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RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

VOLUME XX

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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IN COLLABORATION WITH

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It is inevitable that the present upheaval of the world should entail changes in the order of many things which we have looked upon as fittingly established. Even in the peaceful vocations this is being more and more felt, and it is with reluctance that we institute even a small change in the title of the Archives of the Roentgen Ray.

As foreshadowed in the first editorial that we issued to our readers, circumstances render it essential that if in the future this journal is to continue in a fruitful and progressive manner there must be a closer and more intimate co-operation of those of our readers interested in the many aspects of radiology and medical electricity.

The ever-widening range of application in medicine of X rays, of the

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various radiations from radium, and of electricity, necessitates a greater knowledge of the underlying principles upon which their use is based, of the means taken for their accurate employment, and the significance of the effects to which they give rise. The field for investigation is wide, and if the results of such investigations bear the stamp of validity, it is fitting that a wide dissemination of them should be given to those whose interests are linked in the practice of to-day and the discovery of the morrow.

With this expression of our hopes and aims regarding the future of the Archives and the part which it should play, we trust that we shall have the full and active co-operation of our readers. We cordially invite their assistance, particularly in the direction of sending to us the results of original work in any of the various branches of our subject.

The increased cost of production of the journal necessitates that its price be modified. It is, however, proposed that to all of our readers who are members of some recognised medical or scientific society the price should remain as before, but that in other cases it should be increased to one guinea.

THE INHIBITIVE EFFECT OF X RAYS UPON MALIGNANT GROWTHS.*

By Christopher Kempster, M.R.C.S., L.R.C.P.

Physician to the X-ray and Electro-Therapeutic Department, St. John's Hospital for Diseases of the Skin, and Assistant in the X-ray and Electro-Therapeutic Department at the Cancer Hospital, London, Physician-in-Charge X-ray Department, City of London Military Hospital.

Of the various classes of disease which are treated with X rays the most interest undoubtedly centres around the malignant growths. These have hitherto resisted every known means of medical treatment, but they can, in the majority of cases, be robbed of many of their terrible and distressing symptoms, and, if the growth shows an ulcerated surface it can usually be healed ; when forming a tumour it can frequently be made to disappear, and the disease can at least sometimes be cured by their aid.

Such an innovation naturally evokes a deal of curiosity and speculation as to the manner in which these improvements take place, and what changes in

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*** Read before the London Dermatological Society.**

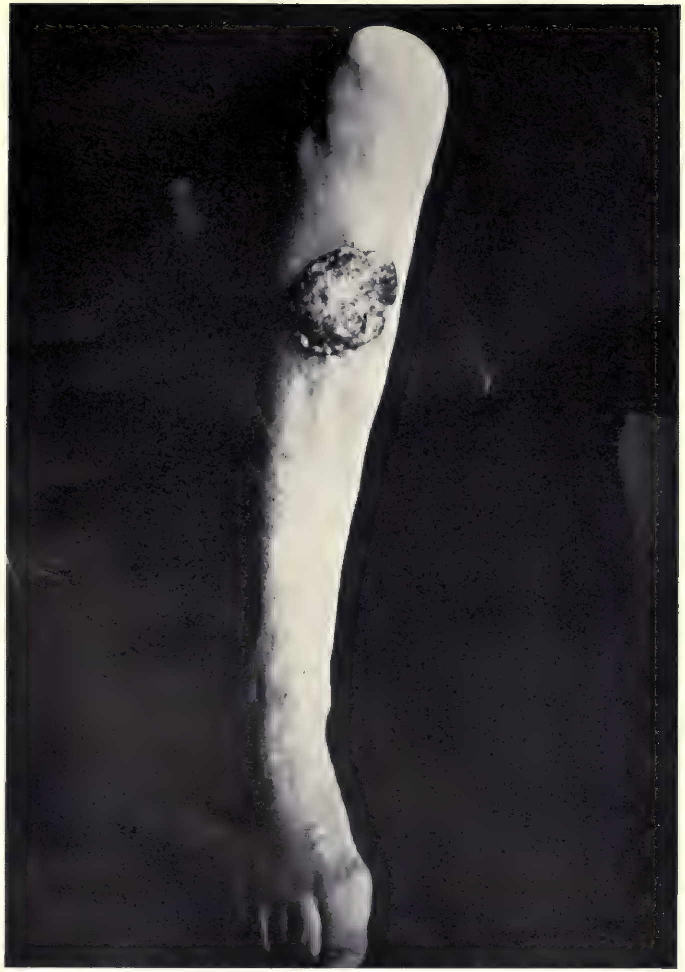


FIG. 1.—Photograph showing large slowly growing fungating epithelioma of leg. Photograph taken before X-ray treatment.

PLATE 1.

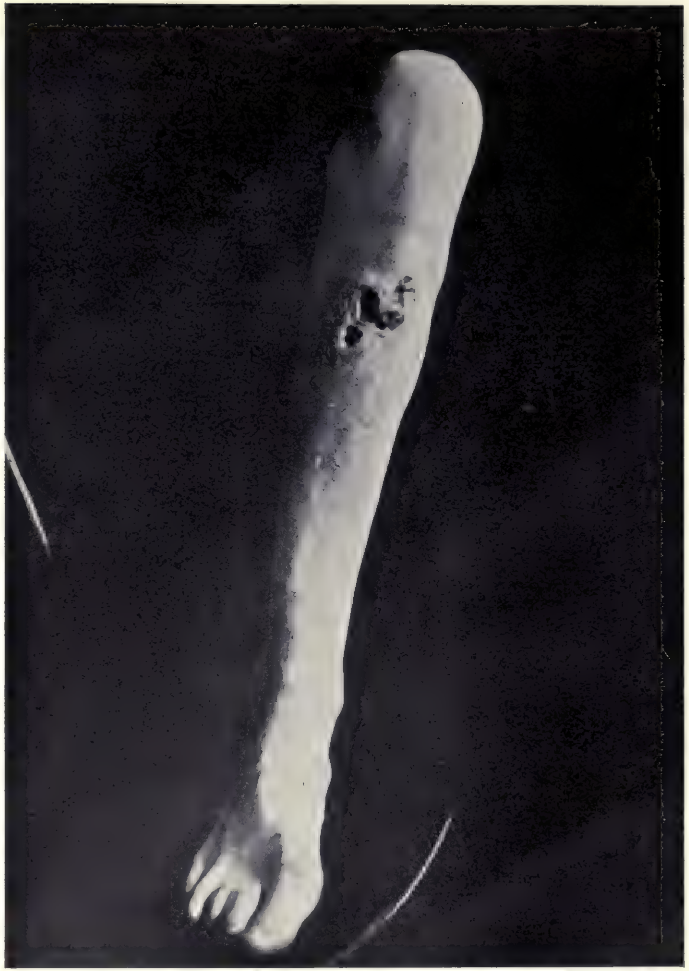


FIG. 4.—Photograph of the leg, showing the site of the epitheliomatous growth after eight exposures to the X rays. The fungating tumour has entirely disappeared and the site presents a clean rapidly-healing surface.

the growth itself are responsible for them. Various theories have been expounded, each supported by macroscopical and by microscopical evidence, each adding a little to the chain of facts which will, perhaps, eventually solve the problem of the causation and cure of cancer.

I have from time to time had under my care at this hospital, and at other institutions in which I am interested, a fairly large number of cases of epithelioma, which I have treated with the X rays with more or less success, some cases doing remarkably well while others have been very disappointing, and strangely, it is impossible to say which will do well and which will not, for given two cases, as far as one can judge, similar in all respects, they may with the same treatment, as far as it is possible to administer it, produce totally different results ; nevertheless, the application of the rays does conform to a fairly constant sequence of results, and in those cases which do well and improve by their use the picture presented time after time is much the same.

For the purpose of investigation epithelioma has several advantages over other forms of malignant disease, for it is as malignant as any class of cancer need be, and when arising from the skin surface it is easy of access and sections can easily be taken for examination from time to time during treatment ; changes taking place in the diseased area can then be observed.

Epithelioma, or squamous-celled-carcinoma, is a new growth which takes its origin from any part of the body where squamous or stratified epithelium exists, but is especially prone to occur on those parts of the body where skin and mucous surfaces meet. It may commence in several different ways, as a slight fissure or ulcer, as a wart, or a little nodule, but in all it is characterised by the early period at which ulceration appears. In some cases the ulceration comes so quickly and extends so rapidly that there is hardly any evidence of new growth, but generally the ulcerated surface is surrounded by a mass of indurated tissue, which is the neoplasm, and presents on section a white opaque surface with a clearly defined margin, though there is no capsule.

Histology.—On microscopical examination the growth is found to consist of columns of cells which are down-growths from the surface epithelium from which the tumour sprang. These cylinders of cells are not enclosed in a membrane, but have a tendency to communicate with each other in the deeper tissues, forming a network. They are connected together by a fibrous stroma which is infiltrated with adventitious cells ; when sections are made across these cylinders the characteristic appearance of an epithelioma is well shown. The sections also present certain round or oval masses, not unlike a bird's nest, and they have therefore been termed " cell-nests." In the centre are one, two, or more spherical cells, around which the squamous epithelium is arranged in a concentric manner, like the layers of an onion, or perhaps more like the petals of a green artichoke.

The rapidity of the growth and the malignancy of epithelioma differ according as it grows from different parts of the body ; an epithelioma of the lip, for instance, grows slowly, and if it is removed freely may never recur ; whereas an epithelioma of the tongue grows very rapidly in most cases and is very prone to recurrence if removed, it affects the lymphatic glands very early, and in most cases kills the patient in a comparatively short time after its first appearance. The chief clinical differences between epithelioma and other forms of carcinoma are, speaking generally, that it is not so liable to dissemination, and to form secondary growths, and that it is not so likely to recur if freely removed. Now we see that epithelioma is essentially a growth consisting of a rapid proliferation of epithelial cells which break through the basal layer of the epithelium and grow downwards, pushing aside the healthy cells of other tissues and in no way attacking or destroying them, but simply making a passage by their growth in between them, the more recently proliferated cells of the neoplasm taking a position more deeply and more distantly from the point of origin than the older cells.

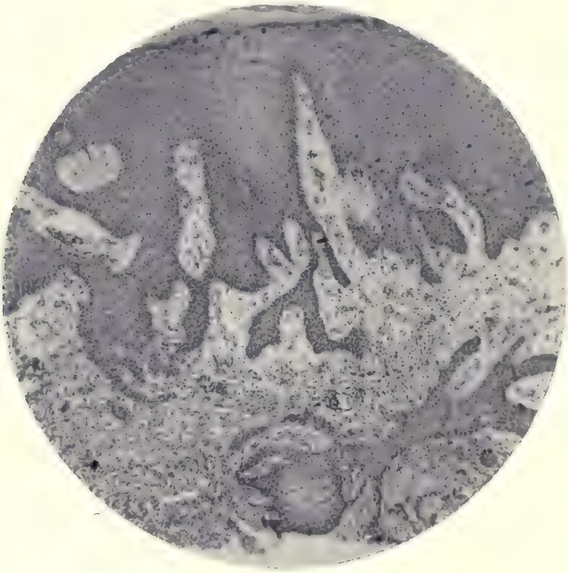


Fig. 2.—Section taken from neoplasm, under low power, before X-ray treatment, showing rapidly proliferating down-growths from the surface epithelium.

Action of X rays upon morbid cells.—We have learnt by observation that the X rays when applied to a new growth have a certain definite selective action upon them, according to the relationship which the new cell bears to the embryonic state, that is, the more nearly the cell approaches the embryonic condition the more profoundly it is affected by the rays.

Generally speaking, the effect of the rays is one of stimulation when administered in small doses, of retardation of growth in medium doses, and of destruction in large doses. This, without doubt, is true; for if we apply a small dose of X rays to a skin surface, the seat of psoriasis, we find that the trouble soon clears up on account of the deeper and healthy layers of the epithelium being stimulated and coming to maturity, and thus casting off the diseased epithelial cells at the surface.

If, on the other hand, we apply a large dose of the rays to a diseased skin surface we find it becomes inflamed and ulcerated and the tissues are destroyed, but if we could so judge our dose so as to administer an amount of X rays sufficient to just kill those cells which more nearly approach the embryonic state, but not sufficient to destroy the normal healthy tissues, we should get rid of any neoplastic growth which may be present and restore the area to a normal healthy condition.

Now this is exactly what is thought to take place when an epitheliomatous area is successfully irradiated ; a dose is administered to the area of such quality of rays and for such period as is estimated to be capable of destroying cells of the new growth, but at the same time of not sufficient quantity to destroy normal tissue cells.

The cells of the neoplasm thus killed are absorbed by an invasion of small round cells which themselves take their place and eventually develop into keratotic tissue. If this is really what does take place we should expect to find in sections taken from the growth at periods after irradiation profound changes in the new growth cells, varying according to the amount of irradiation which they have individually received, that is, according to their position in the growth, whether they be superficially placed or whether they be deeply placed, according to the distance at which they are situated from the anticathode, and also in proportion to the age of the individual cells, for the younger and more immature the cell the greater is the effect of the X rays said to be upon it.

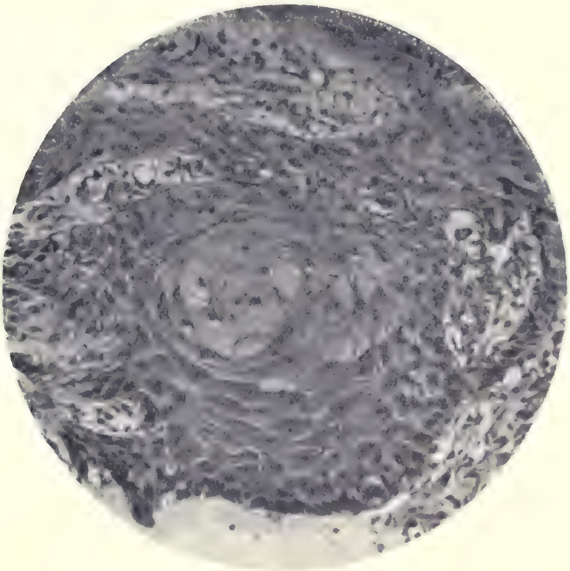


FIG 3.—Same section under high power, showing a "cell nest" containing many layers of cells, all of which retain the stain well.

If this is so we should expect to find in a section of epithelioma which has been irradiated evidence of destruction of cells greater at the surface than at a depth from the surface, and the greater the depth the less the evidence of destruction, and also that the younger cells had suffered more profoundly than the older cells, and when we remember that the down-growth of cells in an epithelioma are practically at right angles to the surface, and that the newly proliferated cells are at the outer or growing edge of the growth, we should expect to find these younger peripheral cells destroyed to a greater degree than those older cells situated internally to them. Again, in the "cell-nests" we should expect to find the younger central cells destroyed before those at the edge of the cell-nest.

Figs. (2, 3, 5 and 6) are micro-photographs of sections which have been kindly prepared and mounted for me by Mr. Garner, Histologist to this hospital; they have been taken from the same case, that of an elderly lady who had a slowly growing epithelioma on the front of the leg, and they show a very good series of the progress of a case which has done remarkably well under X-ray treatment. If we carefully examine these sections I do not think that we shall be satisfied that the conditions which I have just described are evident. We do not find that the cells more superficially situated are more profoundly affected than those more deeply placed, neither do we find that the younger cells, which in the vertical down-growths are situated in parallel lines with the older cells and thus receive the same amount of irradiation, are more affected than the older ones, neither do we find that the central cells of the cell-nests have been selected in preference to the peripheral and older cells. In fact, I do not find any particular evidence of destruction of cells at all, whether superficial or deep, young or old, but there is certainly evidence of the disappearance of malignant cells, the down-growths being interrupted in places, and isolated islets of epithelial cells, old and young, are found here and there cut off; the intervening spaces are filled

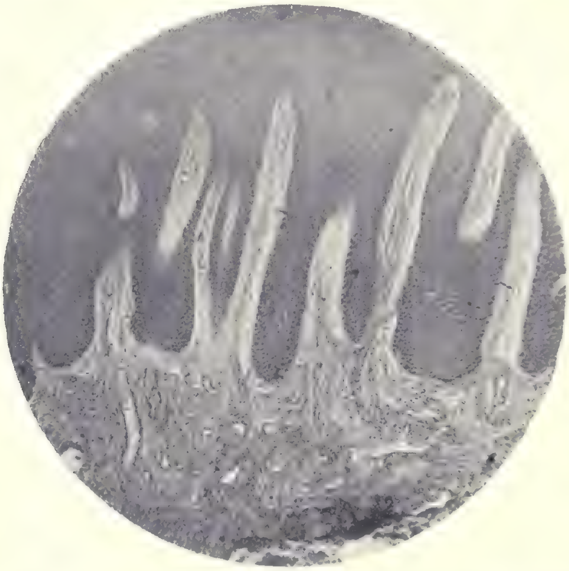


Fig. 5.—Section taken from site of growth after eight irradiations, showing arrest of proliferation of down-growths; small cell infiltration and formation of connective tissue.

with small cell infiltration which has, in fact, been converted into connective tissue.

The older epithelial cells also do not take the stain so well as formerly, whereas the younger cells have not altered in this respect. The cell-nests also appear to be looser, and do not contain so many layers of cells, and the outer ones do not stain so deeply as the inner ones. It is evident, therefore, that any change which may be taking place is in the older cells and not in the younger.

It is certain also that this case was changed from a slowly growing, foul ulcer, with a fungating cauliflower growth, into a somewhat rapidly healing lesion with a healthy base, free from fungation and free from smell; the patient, too, who before the treatment was in a weak state of health, and showing all the signs and symptoms of cancerous cachexia, has gained in strength, vitality, and appearance.

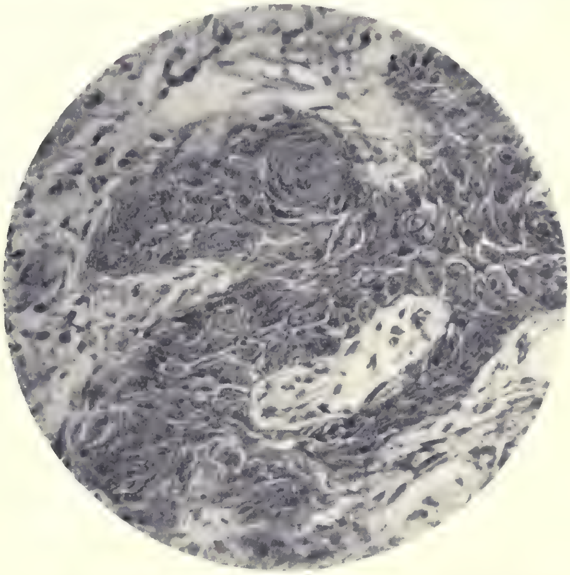


FIG. 6.—Cell nest from same section under high power showing loosening of the layers of cells and a reduction in the number of layers. The outer layers of cells do not take the stain well.

It may be asked, how it is, since there is so little evidence of destruction by the rays, that improvement has taken place both in the patient and in the growth, and whether it were not accidental and quite apart from the rays, since they had so little destructive influence upon the cells as administered?

I should reply that the good effect on the growth was in consequence of the rays, and not in spite of them, and also that the rays have a decided selective action upon the cells, and that the action of the X rays is such that any cell, whether malignant or non-malignant, young or old, can be completely destroyed by the rays, and in such order that the young cell is selected for destruction in preference to the old cell and malignant cell, before the healthy normal cell, and that there is a critical stage at which each cell succumbs to the destructive effect of the rays, but in order to cause the disappearance of a new growth it is quite unnecessary to destroy a single cell, as there is another influence which can be brought to bear which is, in the end, more efficient and safer to the healthy tissues, and it is this force which I believe to have been the means of the change in the neoplasm.

This influence of which I speak is the influence of inhibition of the power of division and sub-division of the cells, or in other words, inhibition of proliferation, for there appears to be at this period of the life history of the cell a greater susceptibility to the effect of the X rays, that is, its power of proliferation is checked or delayed as in the case of the testicle of animals. The quantity of irradiation required to accomplish this is an amount which is not sufficient to actually kill the cells themselves, but is capable of destroying their power of reproduction.

THE TREATMENT OF NON-MALIGNANT GROWTHS BY DIATHERMY.

By E. P. Cumberbatch, M.A., B.M. (Oxon), M.R.C.P.

In the Archives of the Roentgen Ray, for January, 1915, the treatment of inoperable malignant growths by diathermy was considered, and in the same journal for March, 1915, notes of 18 cases were given. Diathermy has also been used for the treatment of non-malignant new growths and infective granulomata, and some cases will now be described. Here, again, as with malignant growths, the treatment is a destruction of the abnormal tissues by heat that is electrically produced within them. The technique and the procedure has been, in the cases treated at St. Bartholomew's, similar in its general plan to that adopted for malignant growths (described in the Archives for January, 1915), and where there is any noteworthy difference in detail it will be mentioned.

The Treatment of Fibromata in the Naso-pharynx.—One case of this kind has been treated at St. Bartholomew's (case 19). It was under the care of Mr. Rose, who has kindly allowed the writer to report it. On account of the severe hæmorrhage that followed when a needle was embedded in the growth, a special electrode was designed. It is shown in fig. 19. An ebonite rod, 4 mm. in diameter and 10 cm. in length—straight, for passage through the

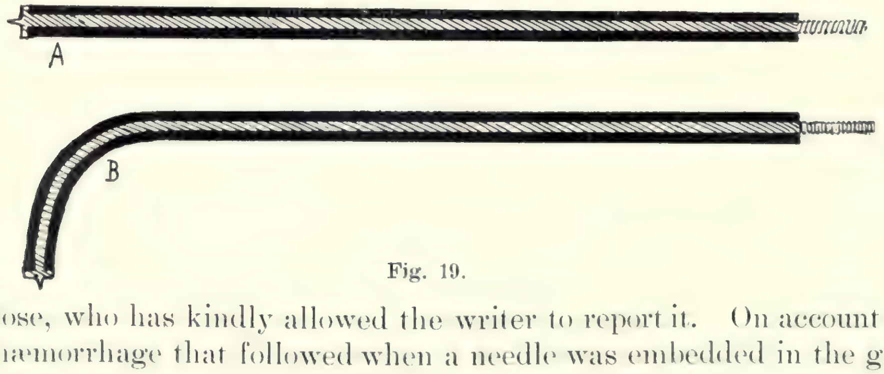


Fig. 19.

nasal cavity, or curved, for passage under the soft palate, is provided with a metal core for conducting the current. One end of the metal screws into the metal core of the usual handle (not shown in this fig.), the other end is fixed to a metal disc secured on the end of the ebonite rod. This disc bears a very short projecting point which serves to anchor the free end of the electrode and prevent its movement off the surface of the growth if the patient should move his head at the moment of passage of the current.

Case 19. J. S., æt. 14. (Mr. Rose's case.) A fibroma of the naso-pharynx had been removed by surgical operation on a previous occasion but it had recurred. Diathermic cautery was then performed. A general anæsthetic was administered. The indifferent electrode was placed on the chest. The active electrode was passed through the nasal cavity into the growth. The first attempt at diathermy had to be abandoned, because profuse hæmorrhage followed the insertion of the needle end-piece of the active electrode (which was used on this occasion) into the growth. On the second occasion the electrode shown in fig. 19 (a) was used. A current of 1·2 ampères was allowed to flow for thirty seconds. It was noticed that if the current was switched on at once in full strength (following the method originally demonstrated by Nagelschmidt at St. Bartholomew's) the patient's head jerked, thereby rendering a movement of the unseen end of the electrode possible. For this reason the current strength was started at zero and gradually increased. After the current flowed for thirty seconds it was switched off and the end of the active electrode was placed in another position on the growth and the current again allowed to flow for the same time. The process was again repeated, and in this way various parts of the growth were coagulated. It was then felt to have become very hot.

Another series of applications was made two months later, and a third series four months after the second. On the third occasion the growth was reached from under the soft palate by means of the electrode shown in fig. 19 (b).

The remains of the growth sloughed away almost completely after the last operation, and when the patient was last seen (one year afterwards) there was a very small remnant visible, and the symptoms of obstruction had disappeared.

The patient did not stay in hospital for more than two or three days after each operation and there was no rise of temperature, except on one occasion when it reached 100° F. There was no post-operative shock on any occasion.

Treatment of Nævi by Diathermy.—A nævus can be heated by diathermy so as to cause coagulation of the contained blood. It is necessary, however, to use a strong current, because the circulating blood dissipates the heat generated by a current just strong enough to coagulate a fixed tissue. When a stronger current is used the blood is coagulated and also the walls of the blood vessels and the tissues lying in between the vessels. The skin overlying the nævus is cauterised in the region of the insertion of the active electrode, and if the nævus is transfixed in many directions so as to ensure its complete coagulation, a large slough is produced. For this reason, the treatment of nævi by diathermy offers no advantage over treatment by electrolysis when the latter can effect a cure. When the latter is not effective, or is thought, at the outset, unlikely to prove so, diathermy may be tried. A single needle is attached to the end of the active electrode and the nævus is transfixed in several directions until the whole is coagulated. Less damage to the skin would probably occur if a needle insulated except at its point were used. The strictest precautions have to be taken against sepsis. This is not easy to avoid in the case of nævi situated on the scalp of hospital out-patients. After the slough has separated the cavity fills with granulation tissue, and new skin grows over slowly.

When the nævus lies in a mucous membrane, healing is much more rapid, and diathermy is particularly suitable, especially if the nævus is of large size, as it can be destroyed usually after one application. The following case (20) is of interest as it was the first in this country to which diathermy was applied. It was one of the three treated by Nagelschmidt at St. Bartholomew's on October 21st, 1910.

CASE 20. E.G., æt. 17. A very vascular pulsating nævus on the right side of the tongue. Electrolysis had been tried previously without avail. On October 21st, 1910, the patient received a general anæsthetic and the nævus was coagulated by diathermy without loss of blood. A large slough formed and separated ten days later and healing was complete four weeks after the operation.

Four years later (October, 1914), the patient came to hospital again, saying that she had noticed some patches of nævus in her mouth. On examination it was seen that there was a small mass of nævus, the size of a small bean, on the right side of the tongue, and two small patches of nævus, one on the tonsil, the other on the wall of the pharynx. On October 7th, 1914, the nævus on the side of the tongue was transfixed with the single-needle electrode and coagulated, under local anæsthesia. The slough separated, and by October 26th the part had completely healed, leaving no trace of nævus. The other patches were treated similarly with equally good results.

CASE 21. W.S., æt. 15. Nævus on buccal surface of upper lip, 1¼ inches in diameter and projecting about ¼ inch from the surface. Under general anæsthesia it was coagulated, using an electrode ending in a single needle. The lip swelled considerably but regained its usual size in three days. The slough separated and the mucous membrane healed in 21 days.

CASE 22. E.L., æt. 17. (Mr. Harmer's case.) This patient had an extensive nævus in the right wall of the nose, in the skin and mucous membrane. She had suffered from severe hæmorrhage from the nose on different occasions, and had been under treatment since the age of five. The facial artery and the external carotid artery had, on different occasions, been ligatured, but without avail. During some of the attacks the hæmorrhage was furious, leaving the patient nearly completely blanched. One of these attacks occurred in hospital and was actually seen. The last attack occurred in May, 1914, and the blood escaped from a channel in the septum in the region of the septal artery. The hæmorrhage was temporarily stopped by pressure. This part was then coagulated by diathermy (in May, 1914). Up to the time of writing May 8th, (1915), there has been no further bleeding and the patient is quite well and has rosy cheeks.

Among other cases of vascular growths that have been treated by diathermy may be mentioned one of lymphangioma on the buccal aspect of the lip of a child, æt. 2. There was no sign of the growth one month after diathermy.

Another case was that of a boy with a vascular fibrous growth, ¼ inch in diameter, springing from his lower lip. It was coagulated *in situ* under general anæsthesia. The growth became dark in colour and dry, and a few days later dropped off.

Another case was that of a man with a small raw area on his lower lip, 1/16 inch in diameter, that constantly bled. The bleeding ceased after diathermy applied under local anæsthesia, and did not recur during the time that the patient was kept under observation.

DIATHERMY AND PAPILLOMATA OF THE BLADDER.—Diathermy would appear to be an admirable method of treatment of papillomata of the urinary bladder, much in advance of any that has hitherto been tried. A method of application was demonstrated at the London Hospital by Frank Kidd, and an account was published in the *Clinical Journal* of April 15th, 1914. The growth was illuminated by a catheterising cystoscope. The active electrode consisted of a metal wire covered with gum elastic, except at its extreme tip. At its other end it was suitably attached to the cable from the diathermy machine. The electrode was passed along the channel of the cystoscope intended for the ureteral catheter. The indifferent electrode was placed on the patient's thigh. To carry out the operation novocaine was applied to the urethra. There was no general anæsthesia. The cystoscope was passed into the bladder, in which 8 ozs. of fluid had been introduced, and the tip of the active electrode was buried in the fimbriæ of the papilloma. The current was switched on and allowed to flow from 10 to 15 seconds, till the patient felt a pricking sensation, when the current was at once switched off. Further applications were made with the active electrode in different positions on the papilloma. At each application part of the growth would whiten and the fimbriæ shrivel. The patient stayed in bed for one day and was able to resume work on the following day.

It was stated that three or four sessions of treatment were required. The appearance of the bladder of a patient who had been treated in the way described—three sessions in all—was demonstrated and described. A small, pale, smooth scar occupied the original site of the papilloma.

In the *British Medical Journal* of November 14th, 1914, is a paper by Andrew Fullerton, in which are described two cases of vesical papillomata treated by the high-frequency current. The method described was similar to that used by Frank Kidd. Three sessions were held in each case, and an interval of 14 days was allowed to elapse between each. During these intervals small sloughs were passed, and sometimes blood. The hæmorrhage ceased when there were no remaining traces of the papillomata. One patient was seen five months after the last session ; there had been no bleeding during this time, and examination with the cystoscope revealed no trace of growth.

This method of treatment was originally suggested by Edwin Beer, of New York. He made reference later to 187 cases treated in this way, chiefly by American surgeons. Fullerton gave, in his paper (*loc. cit.*) an excerpt from an article by E. S. Judd (*Journ. Amer. Med. Assoc.*, November 16th, 1912), in which this author described the treatment, by high-frequency, of 17 cases. There was no recurrence among these ; the patients were kept under observation for varying periods of time. One case was kept under observation for 15 months.

It will be noticed on reference to the accounts above that the treatment has been named " diathermy " by one author, and " high-frequency " by the other. These names do not indicate different methods of electrical treatment. In both the cautery was the result of " heat-penetration," *i.e.*, diathermy, and in both the diathermy was produced by the high-frequency current. The apparatus used by both authors was a portable diathermy apparatus, made by Lœwenstein, of Berlin, and named the "Urodiathermy apparatus." It was demonstrated by Lœwenstein at the International Congress of Medicine held in London in 1913 (Urological Section). It gives a smaller current than the larger machines mentioned and described by the writer in the ARCHIVES OF THE ROENTGEN RAY for August, 1914.

DIATHERMY AND OTHER NON-MALIGNANT GROWTHS.—Diathermy was applied by the writer to a case of papillomata of the skin ("senile-warts"). A group of these, partially fused, forming a mass $\frac{1}{4}$ inch in diameter, sprung from the skin overlying the pectoralis major, near the anterior axillary fold. The base was transfixed in different directions with a single needle electrode, and the current turned on till it was as strong as the patient could bear. The growth dropped off after a few days, and the part healed leaving a scarcely visible scar.

Diathermy was applied to an epulis arising from the roof of the mouth. No anæsthetic was used. There was no recurrence one month later.

It was also applied by the late Dr. Lewis Jones to a case of papillomata of the soft palate. A number of these were present. They were easily destroyed under local anæsthesia.

ERRATUM.

Attention is called to an error which occurred in Dr. H. Martin Berry's article, "Radiography in the Diagnosis of Diseases of the Accessory Nasal Sinuses," in last month's issue. The outline drawing, Fig. 3A should have been 8A, and Fig. 8A should have been 3A.

A MODIFICATION OF THE OCCIPITO-FRONTAL POSITION IN ROENTGENOGRAPHY OF THE ACCESSORY NASAL SINUSES.

CHARLES A. WATERS, M.D.,
Asst. Roentgenologist, the John Hopkins Hospital, Baltimore, Md.

THE emphasis of the occipito-frontal view in roentgenology of the accessory nasal sinuses is due to Caldwell, in America, and Kielian, of Freiburg, in Europe. But since the publication of their work many various and modified methods have been tried with varying degrees of success.

At the present time the occipito-frontal position still remains the method universally employed; and the object of this paper is to direct attention to a slight modification in this method.

It is now possible with this slight alteration in technique to show clearly roentgenograms of the frontal and maxillary sinuses, the anterior and posterior ethmoid cells, on the same plate without projecting into the antra shadows of structures in the base of the skull.

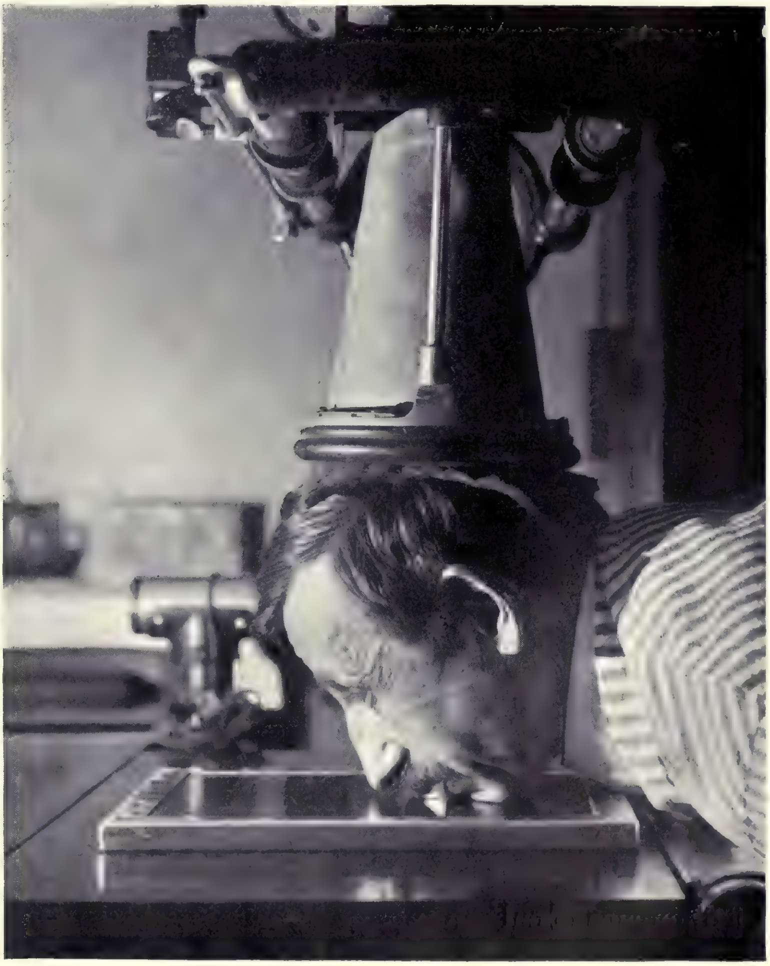


FIG. 1.

Our greatest difficulty in making diagnoses of accessory nasal sinus disease, from the roentgenogram, has been due to the fact that the maxillary sinus and posterior ethmoid cells were always partly obscured by superimposed shadows of Reid's base line.

An important factor in making roentgenograms of the nasal sinuses is being exact in each individual case, and intimately associating one's self with the "style" of head with which one is dealing—that is, the conformation of the skull in different individuals in relation to the course of Reid's base line.

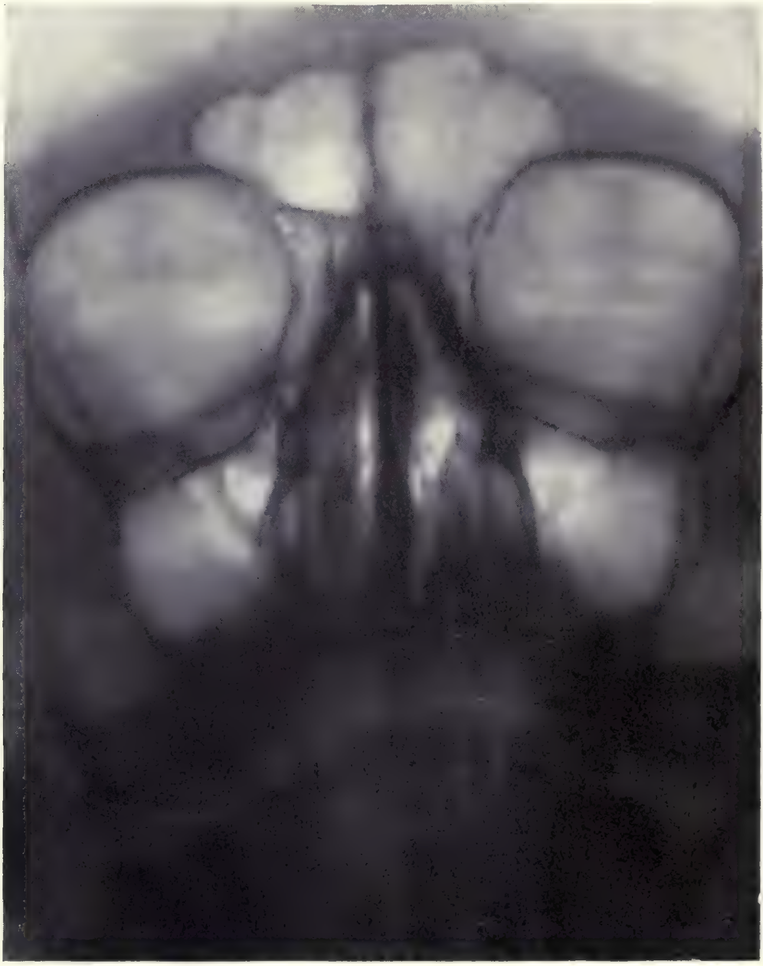


Fig. 2.

We have classified two distinct types, namely, the concave and convex face; and there is a difference of only an angle of two degrees in the entire technique.

Technique.

The patient is placed face down on a horizontal table with the chin resting on the cassette holding the plate and intensifying screen. A compression diaphragm of 18 c.m. in depth is screwed down tightly upon the occiput with a felt pad 2 c.m. thick interposed. (Fig. 1.)

Approximately an angle of 45 degrees is formed by the vertical axis of the head with the plate, but as this is difficult to obtain, we have discarded this point as unnecessary. It will be shown that only three points are essential in order to obtain roentgenograms of this region as described :—

First.—The chin should always touch the plate.

Second.—The long axis of the tube should be parallel to the plate.

Third.—The nose of the patient should be from 1 c.m. to 1·5 c.m. from the plate.

Under no condition should the nose rest on the plate.

Under this rule the importance of knowing which style of head one is dealing with is obvious. For instance, in the convex-shaped face, as shown in Fig. 1, the nose is 1 c.m. from the plate, whereas in the concave-shaped face the distance of the nose from the plate should be increased about ½ c.m., with the tube still remaining parallel to the plate.

Therefore it is the distance of the nose from the plate, with the long axis of the tube parallel to the plate, which enables one to make roentgenograms of the accessory nasal sinuses without projecting the basal structures of the skull into the maxillary antra.

In order to obtain the best results, soft tubes with intensifying screens, a moderate amount of milliampèrage and long exposures should be used.

For instance, our technique consists in using 20 milliampères of current delivered from a 4 k.w. transformer with the rheostat on its three-quarter button. A parallel spark gap of three to four inches and an exposure of 25 seconds are employed.

Fig. 2. shows the accessory nasal sinuses of cases taken in the manner described and seen in Fig. 1.

STONE IN THE SUBMAXILLARY GLAND.

By C. Thurstan Holland.

A young lady, aged twenty-eight years, was sent to me by a physician with a diagnosis of stone in the left submaxillary gland, and a request to show the same by X rays.

The patient gave a short history of painless swelling under the left jaw when taking food, a swelling which gradually subsided each time. This had been going on for six weeks, but was less marked now than when it first occurred.

With one finger in the mouth and another outside there was a sense of some thickening, but no definite hardness could be felt.

Two plates were exposed with the left side of the face downwards, one with the chin midway between flexion and extension, the other with the chin fully extended. The tube was placed straight above the angle of the jaw in each case. A soft tube was used and a short exposure given.

The first plate, with the chin midway between flexion and extension, showed no shadow, the second, with the chin in full extension, showed the small shadow seen in the radiograph produced. In this one the right lower jaw only fell over the stone shadow and this is seen through the jaw shadow; in the first case the shadows of the bone on each side overlapped the stone and its shadow was completely obscured.

The stone, a very small one, whitish in appearance, irregular in shape, and crenated, was cut out from the gland the next day, it weighed 0·31 grains.

The rarity of a successful radiographic result in such cases justifies the publication of this case.

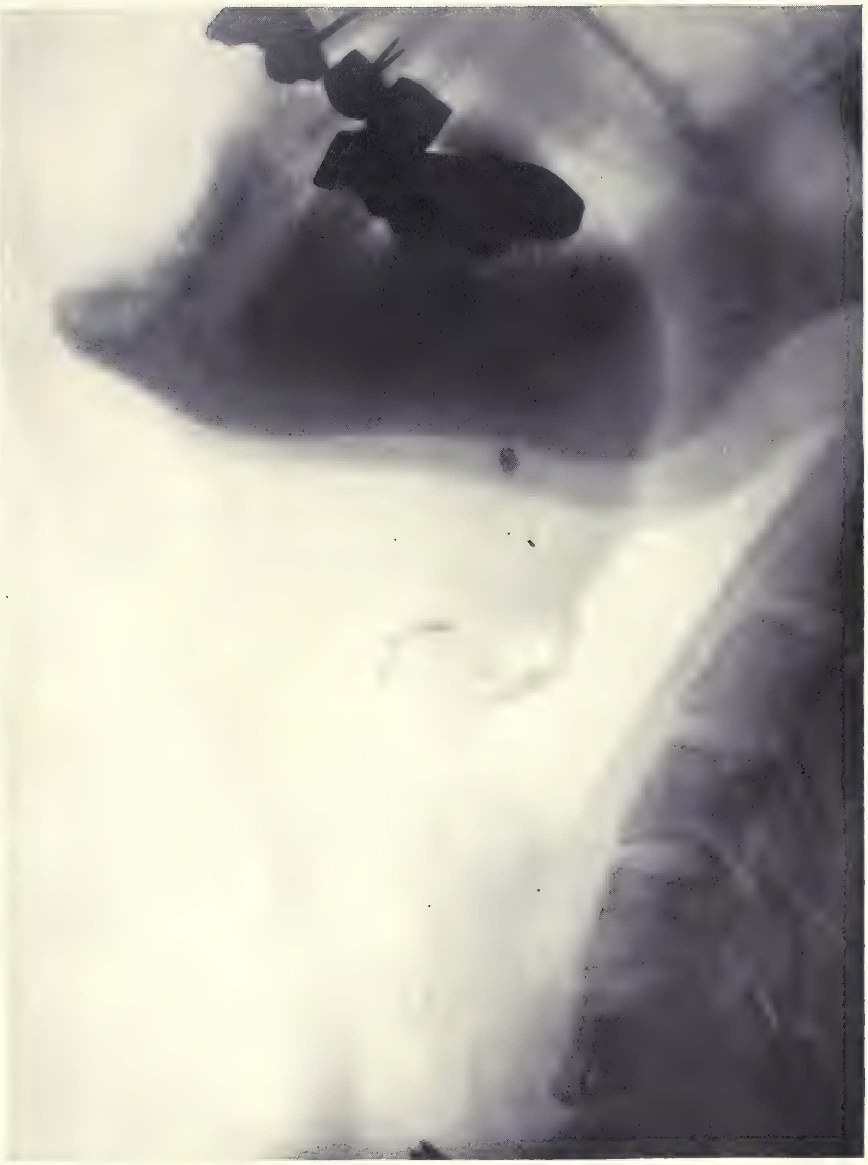
CONGENITAL MALFORMATION OF BOTH HANDS AND FORE-ARMS.

By J. Metcalfe, M.D. London.

The subject is a Russian, aged twenty-four, who is a competent clerk. It is a little difficult to distribute the bones accurately, but the following appears a reasonable explanation :—

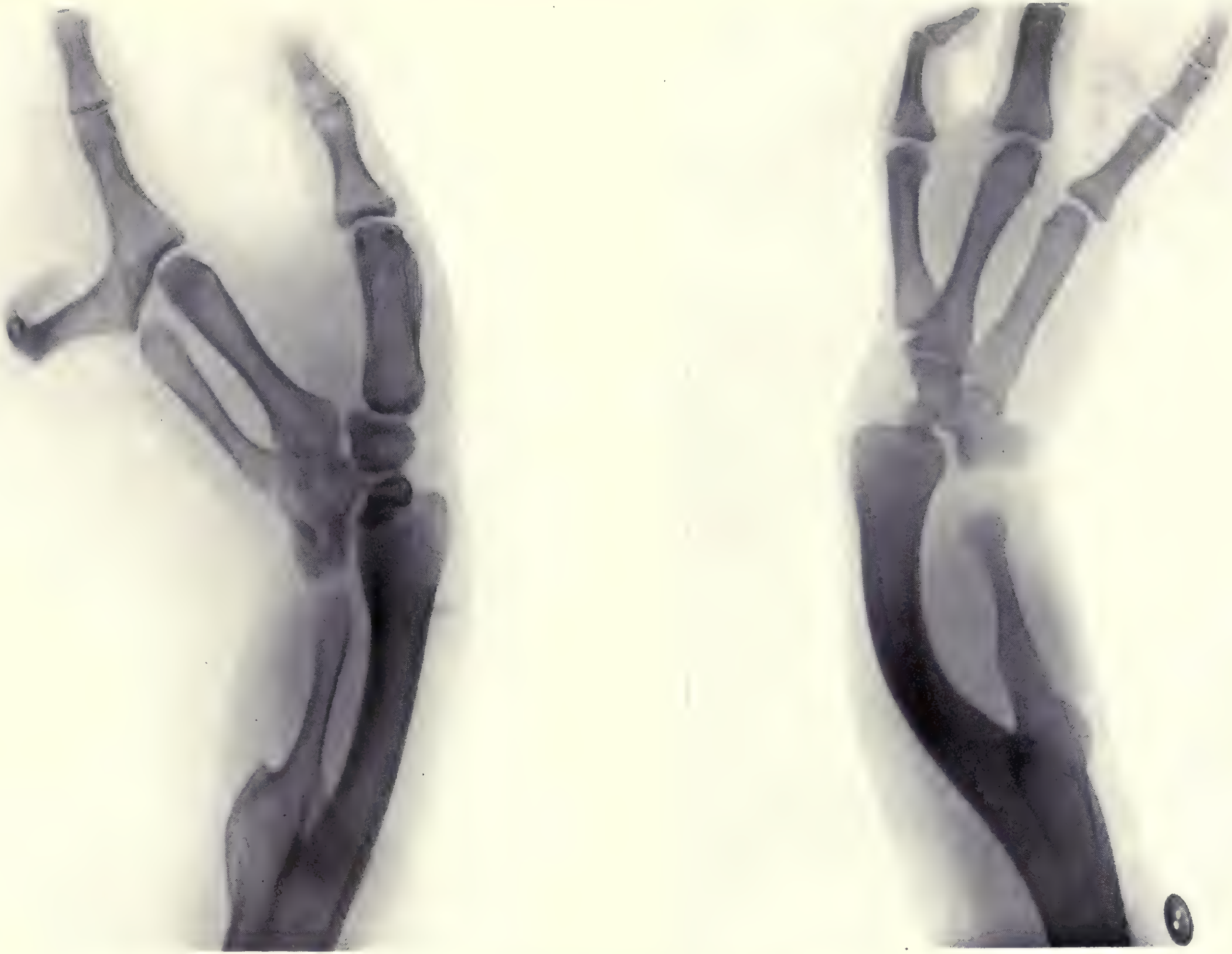
Right Arm shows an ankylosed elbow : bowed and hypertrophied radius : ulna thick above and small below : four or five carpal bones : three metacarpals, one digit with three phalanges, two digits with two each.

Left Arm shows an ankylosed elbow : thick radius : ulna expanded above, undeveloped below : about five carpals and three metacarpals : thumb with two phalanges : little and ring fingers one set of phalanges between them : a bridge between the two metacarpals carries all the phalanges—three going to the apparent ring finger and two to the little finger. (Plate 3.)



STONE IN LEFT SUBMAXILLARY GLAND.
Radiograph by C. Thurstan Holland.

Plate 2.



LEFT ARM. RIGHT ARM.

Congenital Malformation of both hands and fore-arms.

PLATE 3. *Radiograph by Dr. J. Metcalfe.*

REPORTS OF SOCIETIES.

ROYAL SOCIETY OF MEDICINE. ELECTRO-THERAPEUTIC SECTION,

FEB. 19, 1915.

DISCUSSION ON THE ELECTRICAL TREATMENT OF WOUNDS AND SINUSES BY IONIZATION.

BY W. KNOWSLEY SIBLEY, M.A., M.D., B.C., M.R.C.P.

Physician to St. John's Hospital for Diseases of the Skin.

IT is well recognised that the reason why wounds do not heal is because of the presence of pathogenic organisms of various kinds, and that under most favourable circumstances antiseptics can only deal with these in proportion to the way they can be brought into actual contact and made to penetrate into the deeper recesses of the wound. In other words, the antiseptic drug must be brought into contact with the whole of the granulating or suppurating surfaces, and this can most efficiently be done by the process of ionization. By this means not only is the antiseptic brought into complete surface contact, but it is driven through the superficial into the deeper tissues. Thus not only those organisms living in the pus covering the granulations will be attacked, but also those thriving beneath the pus and in the necrotic tissues themselves will be destroyed.

From my experience as a dermatologist in the treatment of numerous conditions of the skin and subcutaneous tissues, I am convinced that for the majority of lesions treatment can be most scientifically and efficiently carried out by means of those electrical processes which convey their influences through the superficial layers to the deeper tissues.

Ionization, as is well known, is the term used to designate the introduction of any drug, soluble in water, through the skin or superficial layers of tissue by means of the constant or galvanic current of electricity.*

The difficulty which arises in the surgical treatment of wounds, especially if of a penetrating nature, is to be able to apply the antiseptic to the bottom of the wound, and so destroy the organisms which are producing the inflammatory mischief. After a time many of these organisms will not only be living in the free pus discharging from the wound, but also be thriving in much of the necrotic tissues deep down in the wound. It is only physically possible for antiseptics, as applied in ordinary surgical dressings, to get at a small proportion of these pathogenic organisms.

It has long been recognised that the process of ionization is excellent for the healing up of chronic sinuses, and it should be equally efficacious if applied to recent ones. So also there is no process of treatment more satisfactory for the curing of ulcerating conditions due to well recognised organisms.

In January, 1913, I treated the case of a little girl with multiple lupus vulgaris lesions over the body. For three years the end of the second toe on the left foot had been enormously enlarged, with a fungating scrofulous ulceration, the nail had gone, and the bone of the terminal phalynx was exposed and necrosed, a condition which to the surgeon would have meant amputation. After some half-a-dozen treatments by ionization with zinc sulphate solution, the whole condition healed up and has remained well ever since.

From my experience of this and many similar cases, I am sure the best and most rapid treatment for wounds would be by ionization, whenever it could be applied, as by this process, and by this process alone, one can be sure that the drug applied has entered deep into the tissues.

The treatment is, moreover, painless—the limb, such as a hand, forearm, or arm, foot, leg, or even the lower end of the thigh is placed in an arm or a leg bath, filled with warm water containing the drug to be applied dissolved in it—the active electrode is placed in this, and the opposite hand is immersed in a basin or beaker containing slightly saline water, into which the inert electrode is put. The constant current is gradually turned on until some ten, twenty, or more milliampères are delivered, according to the requirements of the case, and the process is continued for some twenty to thirty minutes, or much longer, and the treatment repeated daily or more frequently as the individual indications may dictate.

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* Vide author's "Treatment of Diseases of the Skin." E. Arnold, London.

It follows that in dealing with a gaping wound the water, with a drug or antiseptic dissolved in it, will penetrate into all parts which are accessible to the exterior. In the case of a penetrating wound communicating with the surface only by a narrow sinus, it will be necessary to insert the metal electrode, covered with lint saturated with the solution, into the bottom of this.

If on the other hand the wound is one which is suppurating, and has been extensively laid open, the solution will readily penetrate into all parts, and the action of the dissolved drug can be made to act on, and to penetrate into all the regions which are accessible to the water. Thus, wounds of the limbs can be conveniently and comfortably dealt with, those about the head and neck are more difficult to adapt, but it should often be possible to arrange even for these. It is also quite simple to treat by ionization practically the whole body (with the exception of the face) at the same time. In St. John's Hospital for Diseases of the Skin I have arranged a full bath, into which the patient gets, the hands and forearms being placed in a wooden trough, suspended over the top end of the bath, or one or both arms are placed into separate rubber bags filled with water. The drug to be administered is dissolved in the water in the bath, into which is placed the active electrode, the inactive electrode is put into the trough or bags into which the arms are placed, and by this means a circulating current is instituted.

With regard to the drugs used, any drug soluble in water may be applied—the ordinary disinfectants (carbolic acid series excepted), such as permanganate of potash, iodine, chlorine, peroxide of hydrogen, quinine bisulphate or hydrochloride, salts of copper, zinc, or mercury, perchloride of mercury, etc. It will probably be found that the most generally useful drug is sulphate or chloride of zinc, a one or two per cent. solution of which has very cleansing and healing properties, the positive electrode being used. This preparation is especially beneficial for the healing up of chronic wounds or sinuses; in the latter cases a needle or thin pencil of a zinc electrode covered with lint saturated in the solution can be inserted into the sinus, if it is a narrow one. The various aniline dyes—pycktalin (methyl-violet), methelene-blue, scarlet red, the so-called cell proliferants, are also often very serviceable, here again the positive electrode being used.

The same principle of treatment should be efficacious, not only for the purpose of the rapid healing up of chronic, comparatively healthy wounds, but also in those where active suppuration, or even gangrene, has appeared. Whether tetanus could also be favourably influenced future experience will decide. The best and most efficacious treatment for the scars left after the healing of wounds is by ionization with sodium chloride and other solutions, according to individual circumstances. This procedure, especially if combined with a system of hyperæmia by suction cups, often does much to improve the cosmetic appearance of cicatrices.

The constant current of electricity has long been recognised as an excellent treatment for frost-bite. Ionization with various antiseptic and stimulating preparations will soon restore the vitality to the slighter cases, and assist in the removal of the sloughs or gangrene in the severe ones, producing a more rapid healing of the ulcerative surfaces in those where the necrotic processes have extended to some depth.

To sum up, an antiseptic as applied in ordinary surgical dressings can only affect the parts of the wound with which it is actually in direct contact, and in all deep-seated conditions this can only be at irregular areas. In all the other parts of the wound the septic organisms are actively multiplying all the time. The amount of penetration of an antiseptic which takes place in a suppurating wound can only be very slight and must be irregularly distributed. Other things being equal, by the process of ionization, absorption as distinguished from penetration must take place throughout the whole surface area in contact with the solution, and the action of the drug must be regularly and evenly distributed over the whole region under the influence of the electrical current.

Dr. **Charles Russ** believed that with a fuller recognition of the factors at work in suppuration the electric current would be found a very potent remedy. He first approached the subject at the bacteriological laboratory in 1907-09, and he believed there had lately been a realisation of the significance of bacteria in suppuration. On the one hand were the bacteria, associated with their toxins; of the poisonous nature of the latter members did not need to be reminded. Volume for volume, the strongest ordinary chemical antiseptics were poor in comparison. On the other side of the problem was the patient's resistance, and that consisted in changes in both volume and composition of the blood-supply, and in particular the emigration of polynuclear cells. Only when the latter had migrated to the site of a suppurating lesion were they known as pus cells. During the last three or four years he had been studying particularly the effects of electrical currents applied in a special way, and he hoped to show reason for his belief that there were factors directly antagonistic to the bad factors in suppuration which were assistants to the patient's resistance. The types of suppuration about which he would speak—and they were the types he had treated—were cases of ordinary chronic ulcer, such as varicose ulcer, acute septic wounds, usually due to trauma, and infected mucous membranes; in all those cases the factors he had mentioned were at work. In 1909 he had the privilege of reading before the Royal Society[1] a paper on some purely laboratory experiments and observations he had made on the movements of bacteria in fluids—*i.e.*, during electrolysis. The type of organisms he studied were the disease-producing ones: staphylococcus pyogenes aureus, the commonest cause of sepsis, colon bacilli, typhoid bacilli, and other leading groups. Taking the staphylococcus aureus as an example, one took a 24-hour pure culture of that on agar, put it into a tube with 2 per cent. sodium chloride, and emulsified it to keep the organisms alive. The current was then passed through by means of submerged electrodes. Certain facts then emerged. (Slides were here shown.) After a certain period it would be found that the staphylococcus had gone over until those microbes were completely aggregated at one of the electrodes; in the case under consideration it would be the anode. All the experimental work, which he did on the bench before approaching a patient, showed this emigration of bacteria, whether the bacilli worked with were dead or alive; it was due to the affinity between the moving ion and the bacterial envelope. Nearly all organisms in sodium chloride would go to the positive electrode. It came out in a very simple experiment which anyone could do on the bench. By passing a current of only three or four milliampères the effect would be manifest in 20 minutes. He would not now enter into what were the variations in the different fluids. The second important fact was that if one withdrew a portion of the accretion after 20 minutes a large number of the bacteria would be found to be dead, showing that the procedure was lethal to bacteria. Two important facts came out when one was actually treating cases. The lethal effect could be applied against the bacteria in the focus of suppuration. He would instance the first case he treated as an illustration. It was a case of varicose ulcer, chosen because the lesion was easily visible and its varying size could be accurately measured; moreover, the technique could be well adapted to the leg. By the time the ulcer was chronic he found the bacteria were usually mixed; some of the ulcers were four inches square. His object was to draw the bacteria out of the granulations. He fitted a glass vessel over the ulcer and made it watertight with plasticine. He then filled it with a solution of sodium chloride and submerged an electrode, in that way establishing in the human being what he had been doing in the case of the test tube. Organisms left the granulations as the current flowed from the indifferent electrode. Thus, over the lesion one brought a suitable column of fluid, and through that one arranged a circuit in such a direction that the bacteria would leave the lesion. He need not remind members of the perfect cellular contact which a conducting electrode had to make with all the irregularities of a limb. Sodium chloride was not looked upon as a powerful antiseptic, therefore the effect produced was not that of fluid antisepsis. He would like to mention an interesting control experiment which forcibly reminded him of the lethal effect. He wanted to prove whether the organisms were actually drawn out of the granulations, because, of course, no one could see them go. In the U-tube experiment there could be no doubt about the mass movement of the organisms; but on the limb one could not see it. He therefore, before treatment, put on clear saline, and stirred it up so as to get emulsion, and put ¼ c.c. of it on to an agar plate, and he intended to count the colonies. After passing the current he thought he would shake it up again to see if he had twice or thrice the number, the inference being that the multiplication was due to having drawn them out. He got a lot of colonies on the first plate—a thousand or so—while in the second he got nothing, showing that they were all dead. All the ulcers which he treated in that way were healed. His friend, Mr. C. R. C. Lyster, had treated a series of septic fingers, what were known as "casualty hands," the most severe half-dozen which the house surgeon could pick out for him. Pus was welling out from those terrible digits. The 2 per cent. sodium chloride was arranged over these lesions, and not one of the cases came to amputation, the result which often happened. Mr. Lyster, at that stage, was bolder even than he (the speaker) was, for he showed great adaptability in applying a column to the suppurating surface of the eye, corneal ulcers and conjunctivitis; nothing but the 2 per cent. saline fluid was used. The ulcers treated were pale, indolent, and of the washleather type, thoroughly anæmic, but at the end of 15 minutes from the current being passed the vessels were turgid and strongly congested, even to the point of oozing blood. That, of course, was in favour of the patient, for one had produced an effect equal to that of the Bier's bandage, the benefit of which was due to the enhanced blood-supply, the improved plasma flow, and the increased phagocytosis. But the method he was describing could be used for parts of the body in which a bandage could not be applied. He had seen the good effect demonstrated in a distressing condition which he had studied more than anything else—namely, cystitis.[2] When he read his first paper a surgeon in the room said, "Why don't you draw bacteria out of a man's bladder who has got cystitis, for there is a suppurating mucous membrane which is accessible to a column of fluid?" A column of fluid could be put in, an electrode could be let down as a rubber catheter, and a belt carrying a metal core encircled the lower hip, and in that way one enabled the treatment to be applied to the whole suppurating and inflamed surface. He had taken old-standing cystitis cases of years' duration, whose case-books showed a monthly attendance at hospital, or perhaps fortnightly, and in which presumably all kinds of treatment had previously been applied. In all he got the same behaviour—namely, a decline in pus formation, and a great improvement in the symptoms, such as frequency of micturition, and an abatement of the symptoms which had been due to the chronic absorption of coli toxin. After an extensive experience in urine analysis, he knew that organisms in urine from cases of cystitis were seldom seen in phagocytosis; they were seldom seen inside the pus cells. But after treating cases electrically in this way he had some remarkable films showing polynuclear leucocytes literally stuffed with bacteria. Another point was that in chronic suppuration he had seen colon bacilli undergoing morphological change. After treating certain cystitis cases, keeping at the same time an eye on the urine, he found the bacilli becoming definitely longer and stringy, and changed in respect of their reaction to the standard Gram staining, showing an alteration in the chemistry of the protoplasm. When the bacilli attained this increased length they no longer had anything like the same virulence, and there was then no pus formation, or at all events very little. Pus disappeared from the urine after this treatment, and though he had watched cases for 12 months afterwards it had not reappeared, and the organisms remaining were still elongated. He was interested to see whether by passing a weak current through a tube of bacilli the bacilli could be elongated, and that happened, though not so long as in the cases treated. He had also done a considerable amount of work in the study of gonorrhœa in the male on the same principle. He desired, in conclusion, to

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[1] *The Lancet*, July 3rd, 1909, p. 2.

[2] *The Lancet*, Feb, 14th (p. 447), and Oct. 31st (p. 1040), 1914.

project on to the screen a couple of charts from very chronic cases of cystitis. Although they showed only the frequency, the improvement in that respect was *pari passu* with the improvement in other respects, showing that the method truly overcame the causative agent at the back of the suppuration. The first case was at St. Peter's Hospital, and Mr. J. G. Pardoe handed the patient over to him in, he believed, an amused state of mind, for the man had been attending seven years, and had been getting out of bed to pass water five or six times nightly. The man was aged 56, a civil servant, dull, and therefore thoroughly reliable. He cross-examined the patient to get the clear facts. There were staphylococci, the ropy masses, and the scalding and difficulty in micturition, as well as sleeplessness. The method described was applied to him, and the frequency came down, as the chart showed. One night it rose to five times again, but as it was Sunday he (the speaker) focused his attention on the prostate, with good results. The catheter came out stuffed with pus, evidently from the prostatic duct. The frequency came down, and the next night he got out only once. Treatment was finished on April 3rd, 1914, since when he had had no treatment. That, therefore, was a very good case. His urine was not yet free from staphylococci, but it was free from pus. The other case he wished to refer to was an acute one of six weeks' duration. He gave a course and then left him alone. It seemed to be going to relapse. When the frequency got to five times a night he decided to interfere and gave one administration for an hour, and he now had clear nights. At present he could not give more clinical material, but he hoped the remarks would be of service, because if electrical treatment were in future applied to suppuration he thought the method would be profoundly respected by surgeons.

Dr. G. B. Batten desired to express his gratitude to Dr. Russ for his suggestive paper. That gentleman's experiments explained why Dr. Sibley got the good results which he detailed. Might it not be that when Dr. Sibley used zinc sulphate and zinc chloride he placed the limb practically in a positive bath, and immersed the rest of the body in a negative pole? Thus, while aiming at driving zinc ions into the tissues, he was also aggregating the deleterious microbes around one pole. Reasoning from that, Was it possible to get as good results with the substitution of a 2 per cent. salt solution for the fluid he used in the same way as Dr. Russ employed?

Mr. Lyster said the section was deeply indebted to Dr. Russ for making a great advance in knowledge concerning electrolysis. He had had the opportunity of treating a dozen or more cases on the lines Dr. Russ laid down, and he could speak with definite knowledge that quite as good, if not better, results could be achieved with simple salt solution so long as one employed a solution, not a pad. A solution admittedly could not be applied to all parts, but he had succeeded with legs, fingers, and eyes, and he exhibited the identical cups he used for those cases. Twenty years ago electrolysis was used with pads for driving in zinc, mercury, and copper, but the bacteriology of the matter had not been entered into until Dr. Russ did the work he had spoken of for the Royal Society. All present would feel deeply indebted to him for having come to the meeting to explain the process.

Dr. Reginald Morton wished to associate himself with the remarks of appreciation on the work which Dr. Russ had done; it was one of the most important communications which had been made to the section for a long time. It certainly explained many points concerning ionization which were helpful. He hoped the record of Dr. Charles Russ's work was easily accessible, as he wished to study it closely. Dr. Sibley, in his remarks, had said that he used carbolic acid, lysol, and such substances; but it was new to him (Dr. Morton) that such substances would ionize at all. He would mention a practical point because last autumn he had an experience which caused him trouble. It was a case of ischio-rectal sinus, rather deep, which would not heal, although various methods of ionization had been applied; the patient refused operation. What he finally succeeded with was an adaptation of an old method of getting through the chronic stricture of the urethra, using filiform bougies; and one of these found its way into the bladder. This method he applied to the sinus, using many zinc wires, and wherever he found a side track he placed a zinc wire into it, so that he got a wire in every side pocket. After that was accomplished healing occurred after a single application. Many sinuses following upon lacerated wounds were likely to be of the same nature, and it occurred to him that this hint might prove useful to some members. In view of the interesting facts related by Dr. Russ it was more than likely the case was cured, not so much by driving the zinc ions in as by drawing the bacteria out and subjecting them directly to the lethal action of the electric current.

Dr. E. P. **Cumberbatch** said that in the treatment of sinuses his method was to pack the sinus with a zinc rod and connect it with the positive pole. In the cases he had been called upon to treat at St. Bartholomew's Hospital the method had been successful in some, but in others it had failed. When confronted with failure it was necessary to remember three things. First, the sinus might not be clear of foreign bodies. In one case a sinus was discharging a quantity of pus, and the orthodox zinc rod method failed. The case was sent back to the surgeon, who opened the sinus and found a piece of khaki in it of the size of the finger tip, which had not been seen in the radiograph. After the removal of that the sinus healed up at once. The second point was, was the sinus a straight one? If the sinus surfaces were not all touched by the rod, pus would still form. In one such case he had success by using a perforated metal rod, and very fine brass tubing as the positive electrode. He first washed out with water and saline, then zinc, and after passing the tube one got the disinfecting action of copper and zinc ions. Thirdly, one must make sure that the zinc used was a germicide. In many cases he found it was not, because the ulcer or sinus had refused to heal. As an alternative he had successfully used a solution of iodine in potassium iodide—1 per cent. iodide containing iodine dissolved to make it an additional 1 per cent. strength. It was not a case of simple solution of iodine and potassium iodide, but a chemical compound was formed, probably a tri-iodide. It could be proved that the new ion entered when the electrode was connected with the negative pole. By placing a solution of this in contact with the skin the skin became discoloured a faint yellow, but by connecting the solution with the negative pole the skin became an intense brown or mahogany. Recently he had a case of ulcer on the knuckle which refused to heal with surgical treatment or with zinc ionization, but at once yielded to iodine dissolved in potassium iodide. That being connected with the negative pole was one answer to the question raised by Dr. Batten. Another solution which had a germicidal action was sodium salicylate, and he had had a case which healed up with that after failure had been met with even from iodide. Another point he wished to mention in connection with the treatment of sinuses and wounds was the use of X rays. Chronic suppurations and sinuses which had persisted for a long time, and resisted other forms of treatment, had yielded to X rays, and here again help would be derived by placing along the sinus a silver or tin rod. With regard to the treatment of frost-bite, it was first necessary to have an exact definition of "frost-bite," so that all who used the term would be referring to the same condition. He had had two cases of frost-bite in the feet of the anæsthetic type, and he had tried one foot of a patient with one method, and the other foot of the same man with another. He applied to one the rhythmic sinusoidal current to the worst side of one case, and to the other he applied the galvanic current, which had been made to wax and wane. The foot treated with the sinusoidal current recovered much sooner than the other. In another bilateral case he treated both sides by diathermy, and the improvement in looks and in feeling began with the first application. In diathermy he started off by using moist pads soaked in salt solution, but later he placed pads on the skin which had had a little preliminary moistening, and the result was that there were fewer burns than by the other method. He had produced two bad burns by using a damp cloth pad in surgical diathermy, because the salt solution was converted into steam, and this caused two large areas of necrosis; however, the case was moribund from malignant disease. Sprains in St. Bartholomew's students after football he found yielded to the simple galvanic current.

The PRESIDENT said he was sure members had derived a great deal of instruction from the discussion, and he could not close the meeting without saying how much he had been interested in Dr. Russ's remarks setting forth his own method of dealing with bacterial infection. He agreed with Dr. Morton that there was something entirely new in it which was likely to change the prevailing views concerning the electrical treatment of disease.

TREATMENT OF DEEP-SEATED CANCERS BY THE SUPERFICIAL APPLICATION OF HARD ROENTGEN RAYS.

By E. BUMM and K. WARNEKROS,
University Woman Klinik, Berlin.

(*Continued.*)

I. CARCINOMA OF THE UTERUS.

(1.) Mrs. H., 31 years old. Columnar cell carcinoma extending to the front of the vagina, average distance of portio from skin of abdomen 9-14 cm. In twenty successive days a dose of 3,700 X was applied, spread over sixteen skin squares on the front and back of abdomen. After a few days the bleeding and exudation ceased. Then the ulcers became clearer, their size at the portio and at the front of the vagina diminished, and the open ulcers became covered with skin. During the percutaneous radiation several trial excisions were made, and in the degenerated tissue *extensively damaged cancer cells with swollen nuclei were found,* also some still fairly well preserved cancer cells. Fearing to damage the skin we decided to desist from the percutaneous radiation, and gave another 4,000 X during the next twelve days intra-vaginal, after which only degenerating cancer cells and finally *none at all could be found.*

The skin, in spite of some squares having received 350-400 X, after a superficial erythema healed quickly, and has not shown any damage after the lapse of *ten months. The clinical condition has remained excellent, the patient has gained in weight and feels perfectly well.*

In this case the rays had not been exclusively applied externally to the skin; we do not want to cite it, therefore, as a proof that sufficient effect can be obtained from external radiation only.

In the meantime we had found that in mammary carcinomas the quantity of *400 X,* as applied *per skin square,* is not by any means the maximum which one can impose on the skin. We have gradually increased the dose up to *800 X per skin square and could prove that the damage done to the skin was small in proportion to the other results obtained.*

After these data had been obtained regarding the endurance of the skin, we selected six advanced cancerous cases for exclusively external radiation, cases of columnar cell carcinoma with bleeding ulcers over the whole vagina.

(2.) Mrs. K., 37 years old. Tumour the size of a fist, bleeding at the portio, covered with crumbling matter, parametrium free, well nourished. Distance from skin to portio average 10-15 cm. An exposure of 60-80 minutes on the average was given per day, the different squares each received a total of 90-120 minutes during three weeks, at the end of which time the cancer had disappeared. More accurate measurements by means of Kienboeck strips were not taken. In all, there were given about 5,000 X. After eight days one could observe a marked clinical improvement. After fourteen days the tumour was reduced to less than half its original size, and at the end of the third week, the portio had become nearly normal, it being slightly swollen with slight scars at the lips of the vagina.

At the end of the third week a *trial excision in the sclerosed and hyalinic degenerated tissues showed advanced degenerative changes in the cancer cells. In consequence of this favourable microscopical report we interrupted the radiation and gave our attention to the skin, which was now of a red colour and in some places blistered.* On treating it with salves, the healing was rapid, and in a few weeks the skin had healed. The retrocession of the portio continued and the primary cancer entirely disappeared, so that in the fifth week (since beginning of the treatment) the collum uteri appeared under palpatorial and macroscopical examination perfectly normal. The microscope revealed now only a *marked sclerosis and hyaline degeneration of the tissues,* but not a trace of cancer.

(3.) Mrs. Zr., 45 years old. Tumour the size of one's fist at the lower lip of the vagina, covered with lightly bleeding crumbling matter. The average distance of the portio from the skin of abdomen *was 15 cm. or more.* Treatment (with an interruption of six days caused by angina) was continued during five weeks, the total time of radiation being twenty-three hours, the single squares each receiving 100-130 minutes. After five weeks, the tumour had quite disappeared. A trial excision on the now apparently normal lower lip of the vagina showed only a few isolated *degenerating cancer cells in a hyalinic degenerated tissue.*

(4.) Mrs. S., 41 years old. The whole of the portio an ulcerated cancerous area the size of a small plate. During thirty consecutive days, twenty hours of radiation were given over fourteen squares. During this time the portio was reduced to its normal size and the bleeding and discharge ceased. The microscopical examination showed a very marked hyaline and sclerotic change of the tissues with extensive damage to the cancer cells.

(5.) Mrs. K., 41 years old. Very thin and anæmic. The portio and ulcers extending to the vagina were treated as in Case 4. The uterus was displaced to the right and fixed by a stone hard infiltration in the right parametrium, reaching to the right hip-bone. By examination through the rectum, one could feel infiltrations into the pouch of Douglas.

As the cancer was so far advanced, the duration of radiation per square was doubled, so that the single skin squares received during the first four weeks a total of 200-240 minutes.

The deep effect was very favourable. At the end of the second week the ulcerated surface of the portio was perfectly cleared and decreased by half. The radiation was first applied only from the sides of the abdomen, in the fourth week the portio seemed nearly normal and was covered with fresh skin; the *parametric infiltrations were reduced so that the uterus became quite movable. In the last trial excision all cancer cells appeared so extensively damaged as to lead to complete disappearance of their nucleus.*

(6.) Mrs. E., 29 years old, profound anæmia and cachexia, in a very deplorable condition. Large ulcer with discharge from portio and vagina. The cervical channel formed a deep hollow like a crater, covered with a slightly bleeding tumour mass, with copious discharge. Both parametria largely infiltrated, fixed infiltration of the Douglas-folds, uterus not movable.

In this case we at once doubled or trebled the time of radiation per square, so that the patient received during the first ten days 3,900 X, divided over six abdominal squares. The squares over the symphix each received during this period 1,100 X (Kienboeck).

In an excision after the fourth day a marked influence was seen, and the clinical condition improved decidedly. Although the first series had to be interrupted after ten days, as the patient felt weak and experienced frequent vomiting, at the end of the second week the ulcerated surfaces had become quite clear and the tumour was much reduced in size. This reduction and the healing process continued after cessation of the radiation, so that at the end of the third week the portio was covered with fresh mucous membrane, and the uterus became a little more movable. The skin trouble did not prove any more serious than usual, in spite of the larger doses of rays given. After the epidermal blisters had disappeared a new skin quickly formed over the erosions.

A trial excision at the end of the third week showed only very extensively damaged cancer cells in the sclerositic and hyaline degenerated tissues.

As in the meantime the general condition of the patient improved, the appetite having become better and the vomiting having ceased, we started the radiation again after the fourth week and this time from the back.

The examination shows now a quite normal portio and vagina, the large infiltrations on both sides have practically disappeared, and one can feel in the parametrium on both sides only narrow bands like strings.

(7.) Mrs. K., 41 years old. Portio thick, strongly infiltrated, vagina walls covered with bleeding tumourous mass. The cervical channel forms a deep hollow like a crater, with discharge, the sides of which are covered with crumbling tumour matter.

The patient received in thirty-six days on twelve abdominal squares twenty-one hours of radiation. After two weeks the hæmorrhage had ceased and the discharge was reduced. By the fourth week the portio was normal and the cervix channel showed a smooth skin. At the end of the fifth week, a shrivelled normally formed portio, with a reduced cervix channel, without hæmorrhage or discharge, was the condition.

In this case, which is still under treatment, the microscopical examination is not quite in accordance with the clinical improvement, as in the last excision uninfluenced cancer cells can still be proved. The case shows us that to prove success one should not only judge from the clinical improvement. We continue the radiation from the back and hind-quarters until we find the microscopical report in accordance with the clinical improvement.

II. MAMMA CARCINOMAS

There have been treated fourteen cases only with Roentgen rays. Of these, twelve were inoperable recurrences with very extensive glandular involvement. Two cases had not been operated upon.

The average quantity of rays was 300-800 X for each square of the skin.

With one exception, in which the patient died (in this case during the treatment the disease spread in thousands of nodules over the whole skin), the cases have been cured, that is to say, the nodules and extensive infiltrations have disappeared. One case, which is at present still under treatment, with a very advanced suppurating carcinoma of both nipples, shows a similar tendency of the nodules to spread, a tendency which seems to be increased by the rays. In such cases it is recommended not to first attack the primary growth by central radiation, but to start from the edges and to go gradually towards the centre of the tumour in order to prevent the spreading of the cancer cells into the neighbouring tissues.

One case might be specially mentioned to illustrate the deep action of the Roentgen rays.

A lady, 42 years old, was sent to us, from a hospital as inoperable, for treatment with Roentgen rays. She was in a cachectic condition with well-marked dyspnœa. The whole right half of the breast was infiltrated and swollen, and the right nipple enlarged by an irregular granulated tumour, the size of a child's head, partly open and suppurating. The glands in the axilla under and above the clavicula were enlarged and firmly fixed to the tissues underneath.

Examination of the lungs showed an area of dullness the size of two hands at the low right base, perceptible from the front as well as from the back, and the puncture of the pleura was positive.

The lady had great difficulty in breathing, and the rays had to be first applied in a sitting position. The whole right half of the breast was treated from the front, back, and sides in the most energetic manner until the single skin squares were blistered.

The result was in every respect a splendid one. In seven weeks the tumour of the mamma, the lypmhatic glands and the infiltrations had quite disappeared. The difficulty of breathing had nearly ceased and the general health was excellent. That the infiltrations in the cavity of the pleura had been influenced was shown during the next few months, when the dullness of the lungs gradually diminished. The general health of the patient remained good, the lady has gained in weight and comes regularly every 2-3 weeks for further treatment.

In another case where both breasts had been amputated and a very troublesome recurrence of sarcoma had appeared, the Roentgen rays had a prompt, marked effect.

Twelve months ago the lady in question had tumours in both breasts (giant-cell sarcoma) and had been operated upon in Russia. Shortly afterwards the recurrence took place in the lymphatic glands of the axillæ and neck, and during the succeeding months she observed an increasing difficulty in breathing, with a protruding of the breast bone. When the lady came to us the glands in the axillæ and neck had increased to the size of plums, and the breast bone protruded like a tumour the size of one's fist. The lady could only be in a sitting position because of the difficulty in breathing, both arms were swollen and every movement painful.

After three weeks, the single skin squares having each been treated in all for two hours on the average, one could observe a real diminution of the mediastinal tumour and a partial disappearance of the swollen glands. After another four weeks all the nodules had disappeared and the difficulty of breathing had ceased, the lady being able to breathe when lying down; the swelling of the arms had disappeared. After an interval of three months the lady came under treatment again. None of the squares of the right breast which had been treated in the first series showed any recurrence, but we discovered on the left side of the breast two new glands of the size of a farthing, which however disappeared after having been subjected once to an energetic irradiation. This lady will have to remain for some time under observation.

III. Carcinoma Metastases in the Lymphatic Glands.

We mention here only recurrences whose primary site was not carcinoma of the mamma, as these latter have already been described.

(1.) Mrs. —, very fat, operated on for cancer of the urethra, recurrence in glands, swelling as thick as one's thumb in the loins. Total exposure in all 2½ hours, spread over ten days; glands absolutely disappeared in a few weeks.

(2.) Cancer of the lips. Enlarged glands firmly grown to the tissues right and left of the lower jaw. Exposure of 4 and 2½ hours during three weeks caused disappearance. The same occurred with enlarged glands after cancer of the tongue and cancer of the tonsils.

(3.) A primary cancer of the lymphatic glands in the arm-pit, which was sent to us with this diagnosis by a surgeon. In the left arm-pit two hard glands the size of a plum. At the same time enlargement of the supra-clavicular gland. Total exposure eight hours, divided between three skin squares, caused total disappearance in five weeks.

(4.) The same result was obtained with a recurrence, the size of a five-shilling piece, in scar on abdomen after operation for cancer of the stomach. The exposure was for 2½ hours (total) given on ten days during a period of three weeks.

IV. Carcinoma of the Lung.

An excellent influence upon a deep-seated new formation of bronchial cancer in the left lung was obtained by the use of Roentgen rays.

A man, 60 years old, who for some time had had hæmorrhage from the lungs, coughing, expectoration, general debility and cachexia, had been treated for tuberculosis of the lung without success.

Slowly his troubles increased, with a resulting difficulty in breathing and entire loss of voice. At the beginning of this year the patient observed a swelling of the entire left side of the neck, reaching from the clavicular gland up to the left jaw. A trial excision was made, and the microscopical examination confirmed the suspected diagnosis of cancer. Percussion revealed damping of the left lung, and a Roentgen photo showed a deep shadow over the whole left lung. As, under these circumstances, operation was out of the question, the patient was sent by the hospital to us for treatment.

We irradiated the whole left breast from all directions, front, back, and side, until erythema and blistering of the skin occurred.

The patient has been under the rays for twenty-four hours in all during five weeks, with an extra hard tube carrying as much current as possible.

Hopeless as this case seemed in the beginning, we could see during the second week a marked improvement; the tumour in the neck diminished in size, and the difficulty of breathing became less. At the beginning of the third week the tumours at the neck, which were originally as big as one's fist, had entirely disappeared, there was no more difficulty of breathing, the voice had become clearer and seemed at times nearly normal. With further irradiation, the general health of the patient immensely improved. At the end of six weeks the patient felt quite recovered, and we took a second photo of the lungs which shows perfectly normal lungs. Instead of the intense shadows of the first photo, one can see now the clear definition of the lungs and of the trachea without any pathological indications of disease, also the shadows on the left neck, which corresponded to the tumours of the glands, have entirely disappeared.

V. Carcinoma of Ovaries.

Our attempts to influence inoperable cancer of the ovaries have not led up till now to positive results, at which we are by no means surprised, considering the great masses of cancerous tissues which are formed even in the early stages of the disease. We have, however, obtained marked results in two cases, in which the double-sided tumours with the uterus had been extirpated, but where numerous nodules in the surrounding abdominal skin, intestines, etc., had to be left untouched.

In one case after the operation, the region of the frontal abdomen, divided into many squares, was subjected to radiation up to the navel for, in all, 792 minutes, during seven months. Recently fresh trouble appeared, and a second operation was performed. We found near the navel, just to where the darkened outer skin reached, no signs whatever of cancer and all internal organs quite free, but above this line there were numerous nodules in the peritoneum, in the pleura and intestines. We at once tried strong irradiation, but without apparent success; further troubles appeared and living cancer cells were found in the peritoneum. The radiation was then repeated in large doses with evident improvement.

The second case had been operated upon in September last year (1913). In the pleura, peritoneum, and intestines, many numerous nodules had to be left behind. We irradiated in all for 780 minutes during six months. Then appeared tumours in the liver and region of the stomach, which under intense application of rays (330 minutes causing erythema) disappeared. There is no further ascites, but in trying to repeat the radiation the general health of the patient suffers so much for days, that at present we have had to abandon further applications.

We believe that we have proved by the above mentioned cases that it is possible to influence cancerous tissues by Roentgen rays up to a depth of 10 cm. without danger. By this, the chances are opened to treat successfully cancers of the inner organs, intestines, stomach, œsophagus, larynx, etc., all of which up till now have either been curable only by serious operations or mostly not curable at all. We must, however, insist that success can only be obtained by the application of great quantities of hard rays, concentrated through different points of entry, on the diseased tissue, a treatment which not only requires much time and trouble on the part of the physician, but is also fatiguing and expensive for the patient. If skilfully applied, the effect of the radiation is that all surrounding diseased tissues, which at an operation can easily escape the knife, are attacked and destroyed by the rays, together with the primary growth. If by radiation from outside through the abdomen the cancerous tissue of the portio vaginalis has been destroyed, it must be evident that also the cancerous tissues situated in the large muscles and in the glands must have been influenced, as they are nearer to the source of rays and must consequently have received a more intense radiation.

The healing effect on deep-seated cancers is, of course, limited. This we have especially seen with the cancers of the ovaries, with dissemination of the growth in the organs of the abdomen, and also with certain carcinomata of the mammæ.

In these cases, one is certainly able to destroy a few nodules by the radiation, but in the neighbourhood new nodules will appear, and finally the patients cannot endure the large quantities of rays necessary for such extended cancers. The application of internal radiation in the neighbourhood of the stomach may induce continual vomiting, in the intestines profound diarrhœa may result, in the neighbourhood of the heart, whilst treating deep-seated reappearances of breast cancers, irregularity of the heart action may render the further use of the rays impossible. It will be the task of future technique to overcome these difficulties.

Of minor consequence is the local damage done to the skin, which appears after 500 X have been introduced. If one has applied hard rays exclusively, the skin becomes blistered, throwing off the epidermis. This is easily healed in 3-4 weeks time, but there is no lengthy and deep-seated necrosis, which would result if soft rays were applied. If we obtain a cancer cure with a resulting inflammation of the skin which lasts a month, the price we have paid is not dear.

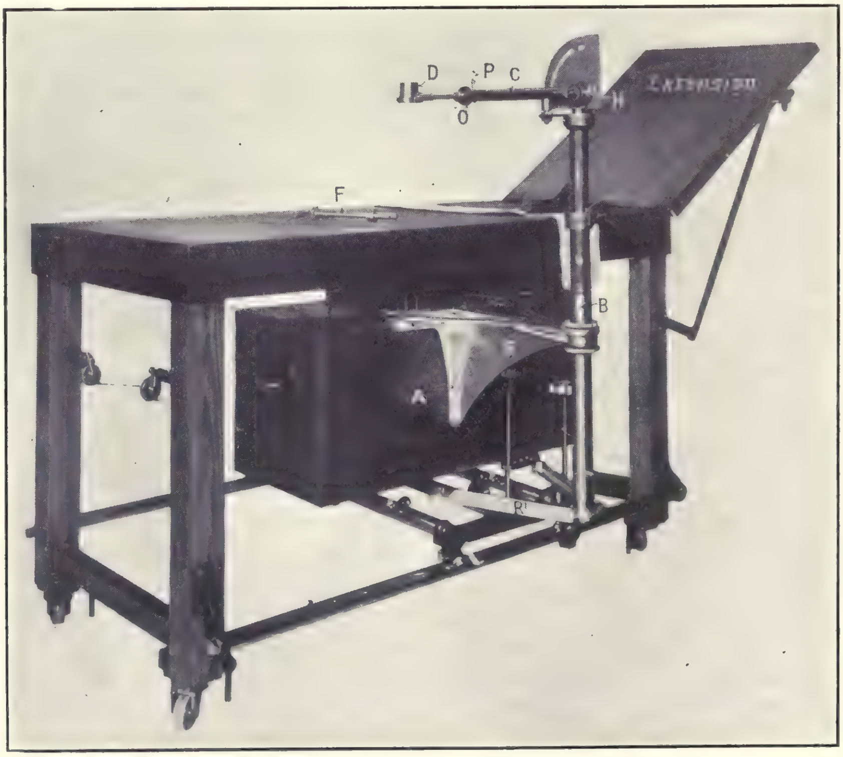
NEW INSTRUMENTS.

AN X-RAY DIRECTOR FOR THE REMOVAL OF FOREIGN BODIES IN THE TISSUES.*

By W. Ironside Bruce, M.D. Aberd., D.P.H.,
Physician to the X-Ray and Electrical Departments of Charing Cross Hospital, etc.

It is possible by means of X-ray to supply information as to the exact position of any foreign body embedded in the tissues—a fact which was first demonstrated by Sir James Mackenzie Davidson, his method being generally admitted to be at the present time most reliable and accurate. Since then other methods have been devised which make for ease of application with accuracy sufficient to deal with foreign bodies of some size in the trunk and limbs. The real difficulty, however, rests in the application of such measurements by the surgeon at the time of operation, and for this reason I wish to draw attention to a piece of apparatus which, if it is at all practical to employ, I believe will lead to the successful removal of foreign bodies from any of the tissues, provided such are accessible from a surgical point of view. The principle involved was made use of some seven years ago, and I produced at that time an apparatus, which (though quite successful) was never developed because it was so complicated and

Fig. 1.



Shows the construction of the couch and operating table, an extension in the form of a flap (attached to one end) allowing for the accommodation of the patient in dealing with the lower limbs. The couch is provided with a wooden top which can be kept clean and will not absorb fluids. The box containing the X-ray tube is marked A, and springing from it, supported by the rigid brackets marked R R', is the upright marked B, to which is attached the cross arm marked C. All these parts are firmly fixed one to the other, and the box, with its attachments, upright, and cross arm can be moved freely and easily along and across the whole length and breadth of the couch. The small circular fluorescent screen attached to the cross arm is seen in the position marked D. There is a sliding joint marked E provided (in the upright) for lowering and raising the screen so that it can be brought close to the surface of the body. On the couch is seen lying a strap for securing the subject and the sterilisable director and guide F.

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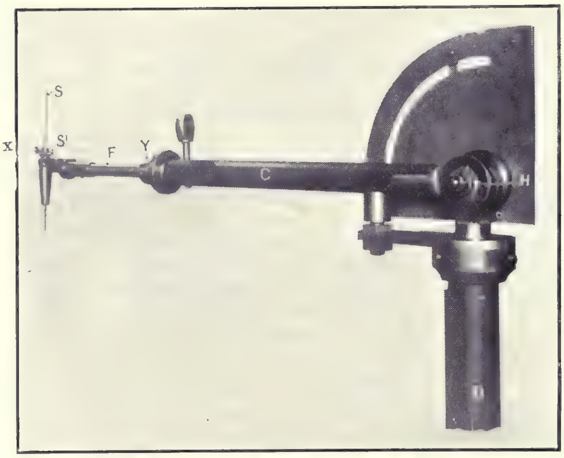
* A paper read before the Medical Society of London on Jan. 25th, 1915.

difficult to apply; moreover, the question of foreign bodies at that time was not urgent.

The presence of foreign bodies in the tissues is now a matter of the greatest importance, and, from what I have seen and heard about their removal, there would be no objection to the employment of a more or less elaborate apparatus, even if costly, provided that such were a decided advantage to the surgeon. Accordingly, the original design has been altered, elaboration remains, but the actual application is simplicity itself.

On proceeding to deal with a foreign body in the tissues, which has been localised previously by one or other of the methods devised, the surgeon is confronted by the following difficulties. The marks on the skin are useless once the superficial incision is made; the knowledge of the depth at which the foreign body lies gives him little help, since the tissues vary much in thickness; and, lastly, the foreign body, which is said to lie directly below a certain point indicated on the skin—a statement correct only so far as one plane is concerned—is missed, for it is often impossible for anatomical and other reasons to maintain the plane indicated during operation, some deviation being made and the direction lost.

FIG. 2.

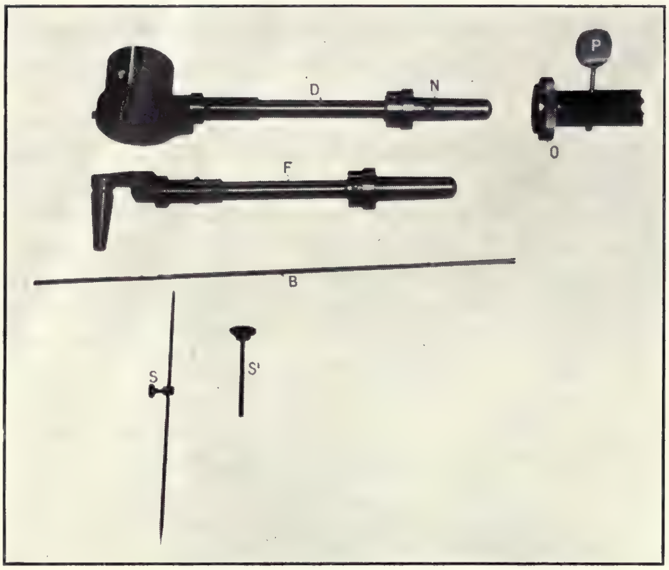


Illustrates the cross arm C attached to the upright B, showing the sterilised guide F and sharp director S attached. The cross arm C can be raised by movement permissible at the joint H, which is constructed so that the arm is returnable into exactly the same position without difficulty. From the point X to Y the arm is sterile when in use by the surgeon.

To deal with these difficulties the apparatus which I am about to describe has been constructed. The first principle involved is the necessity that the position of the limb or trunk at the time of operation should be the same as that at the time of observation. This can only be accomplished satisfactorily by a combination of X-ray couch and operating table, as illustrated in Fig. 1, so that when under the anæsthetic the subject is placed in the position previously selected by the operator, and, having been firmly fixed in this position by means of sandbags and straps, the X-ray observation is made and the operation immediately proceeded with.

Only one observation should be necessary, but it might happen that accidental movement of the subject occurs, in which case there is no reason why further observations should not be made at any stage of the operation, since only a few minutes are necessary for such a proceeding. The use of the fluorescent screen is essential, so arrangements have been made to enable this to be done in daylight, or bright artificial light, the X-ray observer wearing dark glasses for some time beforehand to accustom the eyes to darkness, and an effective fluoroscope being attached. Secondly, the provision of a guide for the operator other than a mark on the skin. It is possible to arrange in connection with the couch a vertical guide which corresponds exactly with the direction of the radiation. To accomplish this, below the couch in a box (Fig. 1A), which can be moved in any direction freely and easily, we have placed the X-ray tube, and springing from this box is a strong and rigid upright (Fig. 1B), to which is attached a cross arm (Fig. 1C) projecting over the couch, all these parts being firmly fixed one to the other, and moving as one piece. At the extremity of the cross arm is attached a small circular fluorescent screen (Fig. 1D), there being provision for lowering or raising the cross arm so that this screen may be brought in more or less close relationship with the subject lying on the surface of the couch (sliding joint in position shown in

Fig. 3.

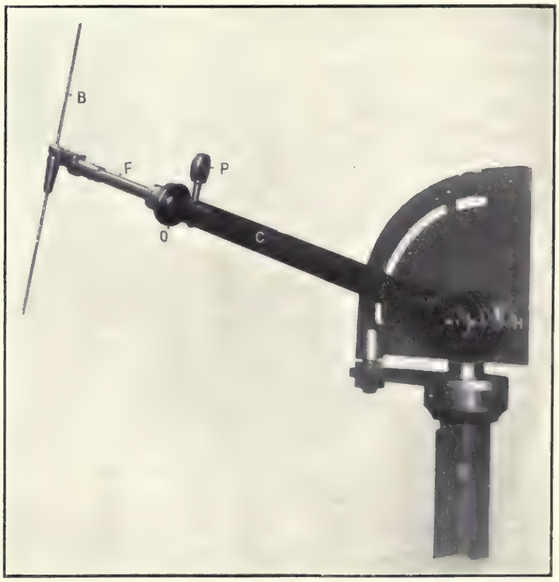


Illustrates the fluorescent screen D showing the cross wires to indicate the screen centre, a point corresponding exactly to the centre of the guide which is shown marked F. The special joint N is constructed so that it is impossible that any change of position occurs, both the screen and guide fitting tightly the same socket and locked in position by the pin P. There is a brass collar, O, which is screwed to the arm and is provided for the purpose of easy removal of the screen and guide from the tight-fitting joint. The blunt graduated director is marked B, and the sharp one with its sheath is shown at S S′.

Fig. 1E). Since the box and X-ray tube are freely movable, and the upright and cross arm are firmly attached to it, the screen will maintain the same relationship to the X-ray tube in whatever position it is placed. An X-ray tube can be so arranged that only the actual central radiation is used, and under these circumstances the shadow of a foreign body as seen in the screen indicates the exact point in space below which that body lies. In other words, if the X-ray tube maintains always the same relationship with the centre of the screen, the central radiation only being used, the shadow of the foreign body seen in the centre of the screen indicates that the body must lie in a line drawn between the tube and the screen centre. In this couch these conditions are easily complied with, for the central radiation is adjusted to correspond with the screen centre, and thus if the shadow of the foreign body is brought central in the screen it must lie below the screen centre in a line between the X-ray tube and that point.

The tube box is capable of being firmly fixed in any determined position to the couch by simply pressing a lever, and consequently during observation when the shadow of the foreign body has been arranged in the centre of the screen, the whole—box, tube, upright, and cross arm—can be firmly fixed to the couch by making use of this lever. When this is accomplished the advantage gained is that we have in the screen centre a fixed point below which the foreign body lies. The screen is detachable from the cross arm (at the specially arranged joint seen in Fig. 3N), and in its place can be substituted a sterilisable metal guide carrying a director (seen in Fig. 3F), the point of which is arranged to correspond exactly with the centre of the screen, which has been re-

Fig. 4.



To illustrate the cross arm C raised out of the way at the joint H, the guide F and blunt director B being attached. The arm can be replaced as shown in Fig. 2 without any change in the position of the guide or director.

moved. The guide permits of movement of the director, only in the direction corresponding to the central radiation—that is, in the line between the screen centre and the X-ray tube, which is, in fact, in the vertical plane. If the director running through the guide is advanced through the tissues its point must impinge against the foreign body, for owing to the whole construction being rigid any deflection from the proper plane is impossible. The advantage gained by this procedure is evident, for the surgeon is provided with a director which will unfailingly lead down to the foreign body, permitting him to deal as he pleases with the intervening tissues.

The guide and director are sterilisable, so can be safely handled during the operation. A joint is provided in the cross arm to allow of the director being lifted out of the way and returned in exactly the same position when wanted. (Fig. 4, cross arm lifted out of the way. Fig. 2, returned in identical position—joint at H). The X-ray observer, from the moment the observation is made, hands over the whole apparatus to the surgeon, and takes away all his part of the construction, so that no unsterilised part is brought near the area of operation.

Two forms of director are provided, one blunt and graduated (Fig. 3B) so that the depth discovered by previous localisation can be made use of, the other sharp in the form of a needle (Fig. 3S) to be introduced in suitable cases into the tissues until the point comes in contact with the foreign body. When using the sharp director a telephone can be attached to announce the contact of the point of director with foreign bodies. The blunt director is provided for use in cases in which it is not advisable to introduce the sharp instrument. For example, in dealing with the abdomen by using this device it is possible to open the cavity, the guide and cross arm being lifted out of the way to facilitate this part of the operation, retract the parietes, bring the director again into place, and gradually advance its point to the depth previously ascertained, dealing with intervening structures as they present themselves.

It is obvious that before using such an apparatus as I have described an ordinary X-ray examination should have been conducted to settle roughly the position of the foreign body and enable the surgeon to decide upon the line of operation, which having been done a surface localisation should be made in order that the depth of the foreign body may be gauged and its position roughly indicated on the skin, to assist in its subsequent observation with the small screen provided in the X-ray director.

In conclusion, I wish to express my indebtedness to Dr. W. Lindsay Locke for many valuable suggestions, and for the interest he has taken in our endeavour to get the apparatus as mechanically perfect as possible.

NOTES AND ABSTRACTS.

RADIO-THERAPY.

Radium in the Treatment of Uterine Hæmorrhage and Fibroid Tumors.—H. A. KELLY and C. F. BURNAM, *J. Am. M. Ass.*, 1914, lxiii, 622.—Kelly and Burnam divide pathological uterine bleeding into four groups, as follows:

1. Bleeding uteri without demonstrable lesions—the so-called myopathica hæmorrhagica.
2. Bleeding uteri in young girls—the cause of which may fall into those in group one or three.
3. Bleeding uteri from polypoid endometrium; *i.e.*, polypoid endometritis.
4. Bleeding myomatous uteri.

The four groups of cases have received radium radiation according to the technique planned by the authors, and a table of their results for each group is given.

From their studies thus far with radium, the following conclusions are drawn:

1. In the classes of cases cited, radium completely and permanently controls uterine hæmorrhage.
2. The rays have a specific and direct action

upon fibroid tumors, causing them to disappear completely or be greatly reduced in size. Furthermore, it does not destroy the ovaries.

3. Radium can bring about a complete amenorrhœa at any age.

4. The menopausal symptoms which follow the amenorrhœa are absent in 50 per cent. of cases, and mild in nearly all of them.

5. Intra-uterine radiation, in contradistinction to cervical or vaginal, is the method of choice. Abdominal radiation in conjunction may add to the rapidity of the results.

6. Radium radiation is preferable to surgical procedures in the vast majority of cases. If radium fails, surgery may have a chance, and there can be no harm in the waiting.

7. Radium is preferable to the Roentgen ray, because it is simpler of application, acts more rapidly, and it acts on the uterus with more intensity than upon the ovaries.

Radium Treatment of Prostatic Cancer.—Pasteau, at a meeting of the Société des chirurgiens de Paris (*Revue de thérapeutique médico-chirurgicale*, March 15, 1914), emphasised the utility of radium in cancer of the prostate. The radium may be applied either in the perineal region, through the bladder after suprapubic incision, by the rectum, or through the urethra. In all cases under his observation radium treatment caused diminution in the size of the growth, disappearance of pressure pain, and an improvement in the general condition, which has been maintained for several years in his patients. When the tumour has been rendered operable by the radium, it should be removed by surgical means. Experience shows that the radium treatment must not be pushed beyond a certain time, as fibrous masses are formed. The author reports a case of prostatic cancer with metastasis in the bladder which ended in recovery under treatment, and there has been no relapse in four years.

Roentgen Treatment in Gynecology.—F. Ebeler, *Strahlentherap.*, 1914, iv, 579.—The technique at first was that of Albers-Schonberg, later 15 cm. focal distance, 3 mm. aluminium filter, hardness of tubes 10 W, intervals of three weeks between the series of treatments. In the beginning 22 fields with 180 to 240 X, later 12 fields with 90 to 120 X per series. Among 32 cases of myoma 21 were treated, with amenorrhœa resulting in 76·19 per cent., oligomenorrhœa in 9 per cent., and failure in 14·2 per cent. Among 20 cases of uterine disease there were good results in 93 per cent., amenorrhœa in 80 per cent. Five cases of carcinomata were treated with Roentgen rays alone, with disappearance of suppuration and pain, and cleaning up of the ulcers. One carcinoma was treated with Roentgen rays and radium combined.

Roentgen - Ray Treatment in Thymic Asthma.—Luzzati (*Rivista ospedaliera*, Aug. 31, 1913; *Zentralblatt für Chirurgie*, Dec. 20, 1913).—Two infants, respectively five and ten months old, with thymic asthma, were successfully treated with the X rays by the author. In the first case the symptoms had appeared in the third, and in the second case in the tenth month, as a sequel to bronchopneumonia. There were loud stridor in breathing and prolonged coughing spells with asphyxial manifestations. During inspiration the clavicle receded, while in expiration it was projected forward, and the upper portion of the thymus gland could then be felt. There was dullness above the sternum, the lymphatic glands throughout the body appeared to be enlarged, the spleen was plainly palpable, and the tonsils were hypertrophied. The first child was admitted at the clinic three times and received in all 42 X-ray treatments. In the second case 32 treatments in succession were given, but with gradually decreasing dosage, so that dermatitis at no time resulted. Both children were relieved of their asthma, the area of dullness above the sternum became distinctly smaller, and, with an X-ray examination, contraction of the thymus gland could likewise be observed. In the first case the stridor also completely disappeared; in the second it was considerably reduced, the lymphatic and splenic enlargements, as well as the other abnormalities referable to the lymphatics, remaining unchanged. The author considers thymectomy indicated only in severe cases that threaten life. In more favourable cases, with asthma and stridor, recovery should generally be induced by prolonged X-ray treatment, at first daily, with moderate dosage. Children of lymphatic habit should be kept under observation, and if signs of a latent thymic enlargement are noticed, treated prophylactically with the X rays.

RADIO-DIAGNOSIS.

The Danger of Pyelography.—*Medical Record*, May 23, 1914.—The first radiogram of the injected renal pelvis in the living subject was obtained by Voelcker, about eight years ago. The great value of this procedure was not at first recognised, and, in fact, very little attention was paid to it until several years later, when Braasch recognised its possibilities in the diagnosis of obscure ureteral and renal conditions, began the systematic use of pyelography at the Mayo Clinic, and, after a considerable experience, made an enthusiastic report (*Annals of Surgery*, Nov., 1910) based upon his observations. This seemed to be the signal for the universal acceptance of the method, and numerous articles soon appeared confirming essentially all that Braasch had written as to the value of the procedure and the indications for its use. Naturally, details in technique, the limitations, and the dangers of its employment still remained to be determined; and of these latter forcible injection of the opaque fluid was found to be the greatest. Accordingly, the technique adopted by most operators has eliminated hand pressure injection and substituted mild hydrostatic pressure obtained by raising the container six to twelve inches above the level of the body, the flow to be stopped at the first complaint of discomfort from renal distension.

It has been demonstrated experimentally that in normal kidneys, so long as the capacity of the pelvis is not overstepped, infiltration of collargol into the kidney substance does not take place. Upon exceeding this capacity, however, collargol is demonstrable in the interstitial tissues; while with still larger amounts injected the silver may be found not only in the interstitial tissue but also in the secreting structure, permeating even into the glomeruli and subcapsular spaces, infiltrating the connective tissue at the uretero-pelvic junction and structures at the hilus of the kidney. When there is a nephritis permeation may take place still more readily, and there is thus an added danger of embarrassing an already impaired kidney by even slight over-distention of the pelvis. This has been demonstrated on several occasions when accidents have followed pyelography.

These facts are now so generally known that it would seem unnecessary to emphasize these points editorially, but for the fact that new operators are constantly entering the field who do not seem to realise the dangers as well as the virtues of the method. That this warning is necessary is attested by the fact that there have been reported recently a number of avoidable accidents due to too strenuous injection. The solution should be allowed to run in under a hydrostatic pressure generated by an elevation of certainly not over twelve inches, and not only should the flow be stopped but a little should be allowed to flow back at the first complaint of pain from renal distention; there will thus be little chance of damage to the kidney. Absolute adherence to these rules is, however, essential if one would avoid the occurrence of wholly unnecessary complications.

Treatment of Senile Gangrene with Ultra-violet Rays.—Kriser has recently been using the "artificial high sun," otherwise the Bach-Nagelschmidt modification of the Kromayer Quarzlamp, in some miscellaneous surgical cases and on a case of senile gangrene, due to arteriosclerosis in a sixty-year-old subject. The gangrene had been preceded for months by severe pains in the limb, and was spreading over the foot, so that it was clearly an amputation case. Prolonged raying with actinic rays, varied at times by the warm rays, completely healed the condition in two months. There was almost a complete restitutio ad integrum, the gangrenous areas having been replaced by thin white scars. The rays at first increased the pains, but these exacerbations were followed by remissions. The cure was probably due largely to the fact that this form of radiation has been known to lower the blood pressure permanently.

The "Artificial High Sun" in Military Medicine.—Thedering first mentions natural high sun exposure, which paved the way for artificial substitutes. Its possibilities were first brought to notice through the brilliant results of Rollier in surgical tuberculosis. Next in order torpid ulcers were made to heal. In the present war it is being used extensively in military hospitals for ragged and gangrenous wounds. The quartz lamp rays are said to have only a superficial action, but in some cases they may be used in concert with X rays. Gangrenous sores may be quickly rendered inodorous, probably through ozonization. It has not yet been shown that the artificial solar rays are bactericidal.

Clinical Notes on Malignant Tumours of Long Bones.—Berry, J., *Clin. J.*, 1914, xliii, 465. By Surg., Gynec. & Obst.—Discussion of sarcoma of bone takes up a large part of the article, which is splendidly illustrated with photographic reproductions of the bone and tumour. Attention is called to the fact that pain may be very slight. Other conditions simulating tumours are cited, for example, the chronic forms of osteomyelitis with bone production in the periosteal region of the shaft. A mistaken diagnosis leading to amputation for this latter condition has come under the author's notice.

Sarcoma of the ends of the long bones leading to joint inflammation and simulating primary joint disease is not uncommon; with it, however, even after swelling of the joint and great pain, movement although restricted is not painful. Old ununited fracture with false joint and tumour-like formations of fibrous tissue may also be taken for tumours.

Alex. R. Colvin.

NOTICES.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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THE STATUS OF THE RADIOLOGIST AND ELECTROTHERAPIST.

In pursuance of the theme of our last editorial—the changes brought about by recent events in conditions regarded as permanent—we deem it well to draw attention to a matter which forms our title for this editorial.

In the early years of Radiology and Electrotherapy, the pioneers in this branch of medical science were relegated to obscure corners in those hospitals which were enterprising enough to inaugurate a special department.

As time passed, however, and the work done in these departments was found to be increasingly valuable and important, better accommodation and greater facilities were provided, and now all large hospitals have well-equipped and up-to-date departments for Radiography and Electrotherapeutics. In many cases the active co-operation of physicists, biologists and chemists has rapidly extended the wide field of this new branch of medicine, and the application in medicine of the physical properties of radium promises to enhance still more the value of the Radiologist. The war at present raging in Europe has opened up another sphere of usefulness to the Radiologist, for he has now become the colleague and right hand man of the operating surgeon in dealing with the results of war—new departments have sprung into existence, as it were with a wave of the hand, and men to work these departments both at home and abroad are urgently required. The demand far exceeds the supply, and must continue to do so unless steps are at once taken to meet the need. The employment of men who have had no medical training, and no special instruction, except in a purely mechanical capacity, is to be deprecated—the essential qualities for a Radiologist or Electrotherapist should be a qualification in medicine and surgery, a training in physics and mechanics, particularly in their application to electrical apparatus, and a thorough training in the taking of radiographs and in radiographic interpretation. In order to meet the demand for trained Radiologists as soon as possible, we would suggest that the following radical measures be inaugurated at several of the teaching schools, and particularly at the military centres at present established throughout the country :—

(*a*) Teaching facilities should be afforded at these centres by the appointment of a recognised Lecturer of Radiology and Electrotherapeutics, or the two might be independently appointed.

(*b*) The establishment at the principal Universities of a chair of Radiology and Electrotherapeutics with all facilities for teaching the subjects.

(*c*) The full recognition at the Admiralty and War Office of the Radiologist and Electrotherapist in a consulting capacity, and the appointment of one or more Consulting Radiologists to the Army and Navy, who should be given full powers to organise and consult in the various departments at home and abroad.

(*d*) All medical men holding appointments as Radiologists or Electrotherapists in hospitals at home or abroad should be recognised as members of the Staff and should have all the privileges of the other members thereof.

Should these reforms be carried out we have not the slightest doubt that in the near future the supply of Radiologists would be equal to the demand—the labourer is surely worthy of his hire—and the present anomalous position being rectified, men would be encouraged to enter a branch of the profession which is unsurpassed in its usefulness, its interest, and in its opportunities for research.

RADIOGRAPHY OF THE MAXILLARY ANTRUM.

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AND

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In examining the antrum by radiography we hold that it is impracticable to use with advantage any exact mathematical measurements of the angle at which the head is placed, owing to the complication of the apparatus and the time taken in its adjustment in the living subject. The fluoroscopic examination provides us with a method which is sufficiently exact for all practical purposes, and it is easier with it than with any other to obtain a true antero-posterior position of the head for the anterior view. Without placing the patient prone it is possible to get the plate much nearer to the antrum than in Dr. Berry's method, described in this journal in May. It must be remembered that radiography of the bare skull is a far easier procedure than the examination of the flesh-covered human head.

There is one warning that must be given: an unduly prolonged screen examination may cause epilation. To prevent this the screen examination should not last longer than is absolutely necessary, and the tube must be a sufficient distance away from the nearest point on the head. Increasing the distance of the tube has the advantage that the rays are more parallel and better pictures are obtained. A distance of the anticathode of twenty inches from the nearest point on the scalp may be regarded as a suitable one, and this means about twenty-eight inches from the plate in the antero-posterior view. A good tube is required to stand the exposure at this distance and a modern apparatus to give the necessary amount of current.

The methods we are describing have been arranged to be suitable with the patient lying on the couch with the tube below, but a satisfactory technique could be evolved with the patient sitting up; they can, however, not be adapted to the method where the tube is placed above the patient lying on the couch.

The most important view is undoubtedly the anterior, *i.e.*, one where the plate is placed against the anterior surface of the head. The oblique views (Figs. 3, 4, 5 and 6), however, undoubtedly have some direct value in the examination of the antrum, though how far this goes we are not yet prepared definitely to state, but their great importance lies in the view of the associated teeth which they give and their usefulness in detecting abnormalities of these which may not show or may only be suggested in the anterior view. A view from above downwards could be obtained in some patients, but a study of radiograms of the skull, where the conditions for getting this view are ideal, show that it has no advantage over an anterior view.

In examining a bismuth-filled antrum in a skull we found that the best angle for the examination of the antrum was obtained when the normal incident ray passed parallel to the base of the skull and about one-and-a-half inches below it (Fig. 1). To obtain this view in the living, the patient is placed flat on the back and the head raised by a sand-bag or block placed under the occiput ; the thickness of the sand-bag varies in different patients, but usually lies between one-and-a-half and two inches ; the head is tilted forward. To support the screen we find it convenient to use adjustable supports, and they are so arranged that the screen just presses a little on the patient's forehead, while at the same time touching his nose. To determine whether the head is straight the appearance of the nasal septum usually forms a good rough guide, but, to get this more accurately, the relations of the mastoids and the zygomata with the ramus of the jaw must be the same on each side. By rotating the head with a protected hand this can easily be done. Fig. 2 shows the result obtained ; it can be seen that details of the base of the skull are obliterated owing to its being foreshortened into quite a narrow strip on the plate, but the antra stand out quite sharp and clear ; a comparison with Fig. 1 will assist the inexperienced to read the skiagram. The head is rotated in the opposite sense for this antero-posterior view to that of the skulls figured by Dr. Berry in the May number. It is very important to observe that the frontal sinuses, unless very large, are obscured in this view ; to obtain them the head must be laid flat on the table ; on the other hand an excellent anterior view of the sphenoidal sinuses is obtained.

The oblique view is not so easy to describe. The head is still placed on a sand-bag and rotated a little to one side. The shadow of the zygoma is now seen on the side towards which the head is rotated, crossing a rectangular clear space, the shadow of the orbit (Figs. 3 and 5). A position in which the zygoma bisects the clear space will give the two antra side by side and not overlapping. One side of the alveolus is nearly perpendicular to the plate, it is thus thrown clear of the other side and gives a good view of the teeth from the molars up to the canine ; the antrum best seen in this oblique view, however, is on the opposite side to that on which the teeth are shown, and a similar oblique view is made of both sides for comparison. If the two oblique views (Figs. 3 and 5) of the skull, with one antrum filled with bismuth, are compared, the relative positions of the two antra in this view will become apparent ; it will be noticed, in the right antero-lateral view, that the antrum is not completely filled. The comparison should be made between the antrum containing bismuth and the corresponding one on the opposite side containing air. The normal antrum in a child is illustrated by Figs. 7, 8 and 9.

Having described the normal appearances, we now pass to those met with in disease. As a general rule the chief indications are obtained from the contents of the antrum. This is normally full of air, and if for any reason this air is replaced by liquid or solid matter the antrum will appear darker on the skiagram. We emphasize the fact that the antrum may be diseased, but may contain the normal amount of air and so not show evidence of disease ; the discharge may, for instance, have been emptied just before the radiogram is taken. When, however, the mucous membrane is thickened or polypoid, the antrum will always be darker than normal, as some of the air is replaced by these semi-solid substances. Actual thickening of the bony wall will, of course, produce marked opacity, and this is probably the reason that antra which have had a radical operation done on them are always very opaque.

We now come to the significance of the X-ray findings, and they must be taken in conjunction with the other physical signs. Radiograms are only one method of examination, and like every method are not sufficient in themselves alone to base a diagnosis on. The patient's history and symptoms must be taken into account, anterior and posterior rhinoscopy must be performed, and the antrum must be transilluminated. There is an unfortunate tendency among medical men to think that transillumination and X rays can be used as a substitute for one another. This is by no means the case. Using these two methods it is obvious that we can have four different possible combinations of results :—

(1) Antrum clear by both methods.
(2) ,, dark ,, ,, ,,
(3) ,, clear to transillumination and dark to X rays.
(4) ,, dark ,, ,, ,, clear ,, ,,

The indications presented by these various combinations are as follows:—

(1) When an antrum is clear by both methods it is unlikely that it is the seat of disease.
(2) An antrum dark by both methods occurs with—
    (*a*) Antrum containing pus.
    (*b*) Chronic degeneration of the mucous membrane with pus. This may be either sloughs with pus or polypi with pus.
    (*c*) Antrum which has been operated on (sometimes).
    (*d*) Neoplasm.
(3) An antrum will be clear or hyper-clear on transillumination, but dark to X rays when—
    (*a*) Containing polypi.
    (*b*) There has been a radical operation but the antrum has become healthy.
    (*c*) Probably when a large dental cyst occupies the antrum.
(4) An antrum dark to transillumination and light to X rays indicates—
    (*a*) Inflammation with mucus formation but no old-standing disease. Cases of septal deflection which are dark to transillumination probably come under this category.
    (*b*) Big face bones.

The other symptoms and physical signs associated with inflammatory disease of the antrum are :— pain over the antrum, tenderness, swelling of the cheek, unilateral nasal discharge (in unilateral cases), an unpleasant smell which patient experiences, chronic post-nasal catarrh, unilateral nasal obstruction, a streak of pus seen under middle turbinal (also seen with frontal sinus suppuration), polypi in nose (due to co-existing ethmoid disease), pus or mucus on puncture, syringe blocked on washing out suggesting polypi, and pus seen in middle or inferior meatus on posterior rhinoscopy.

The radiograms illustrating the cases should be compared with those of the injected skull, and to facilitate this the three views of the first case are placed opposite to similar views of the skull. In this case the right antrum is opaque, and this is well shown both in the anterior view (Fig. 2) and in the oblique views (Figs. 4 and 6): it will be observed that the difference in opacity can be distinctly seen in *both* the oblique views. In Fig. 3 it will be noted that the bismuth has not completely filled the antrum ; it will also be seen that the Figs. 3 and 5 are not taken at precisely the same angle. The case illustrated in Figs. 2, 4 and 6, is one of chronic suppuration of the antrum, and clinical evidence showed it to contain pus. Transillumination showed that it was opaque and therefore contained either mucus or pus ; X rays demonstrate that it must be pus on account of the opacity, and pus was in fact seen issuing from under the middle turbinal. This case also illustrates the value of radiography to demonstrate any associated trouble with the teeth. In front of, and behind the first molar on the right side, the antral floor is seen to dip down. An intraoral skiagram (Fig. 4a) showed that there were cavities round the roots of this tooth, at least one of which appeared to communicate with the antrum.

Figs. 7 and 8 illustrate oblique views and Fig. 9 the anterior view of a child's skull in which the left antrum has been filled with bismuth. It will be noted that the alveolar portion of the antrum is not so well developed as in the adult. The oblique views demonstrate how well the teeth are shown in this picture.

Fig. 10 illustrates a more advanced case of the same condition as Fig. 2. Here the cavity of the right antrum was full of pus and sloughs from degenerated mucous membrane. The right antrum is so opaque that its outlines can only with difficulty be distinguished.

Fig. 11 illustrates several interesting points. It will be noted that the right antrum is opaque, also the left sphenoidal sinus, but the left antrum is clear. The right antrum and left sphenoidal sinus were found to contain polypi, and the left antrum contained clear mucus. Transillumination of the antrum showed the right side clear and the left dark, the converse of the X rays, and this enabled a correct diagnosis to be made before the operation.

Fig. 12 illustrates a case of antro-choanal polypus, the right antrum being occupied by one large polypus. This was a patient examined twice. On the first occasion the right antrum was clear on transillumination and on the second hyper-clear. The X rays both times showed the right antrum opaque. On the second occasion, during the course of an attack of influenza, with a muco-purulent rhinitis, the left antrum became dark on transillumination. The radiogram reproduced is taken at this time and shows the left antrum clear.

Figs. 13 and 14 indicate cases of antra which have been operated on (Caldwell-Luc operation) but which at the present time are healthy. In both these cases the antral cavity which had been operated upon was found to be covered by smooth healthy mucous membrane by digital examination under general anæsthesia.

Fig. 15 shows a slightly opaque left antrum due possibly to inflammation spreading from an unerupted canine, which is better shown in Fig. 16.

We think we have demonstrated sufficiently the value of the X-ray examination to show that there are few cases of suspected antral disease in which it can be dispensed with.

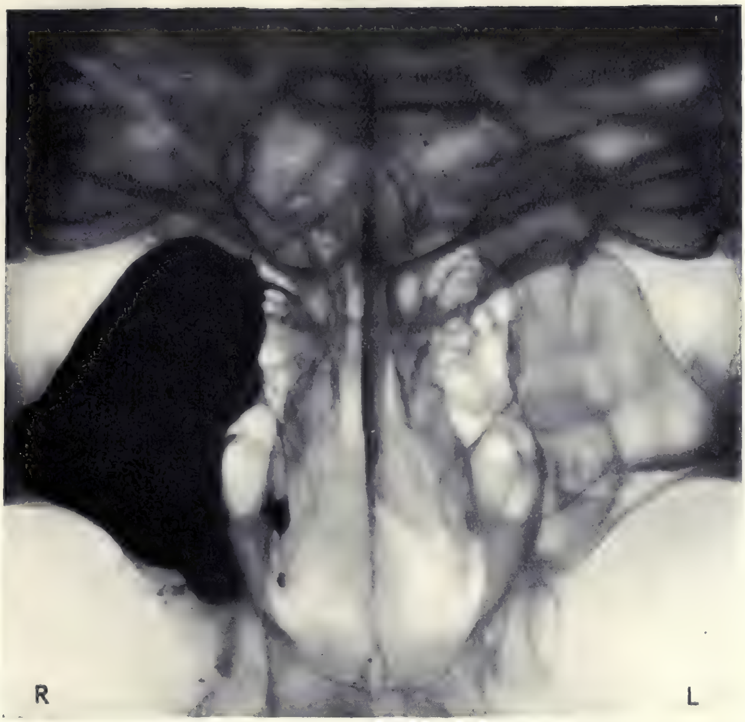


Fig. 1. Adult skull, anterior view. Right antrum injected with bismuth.

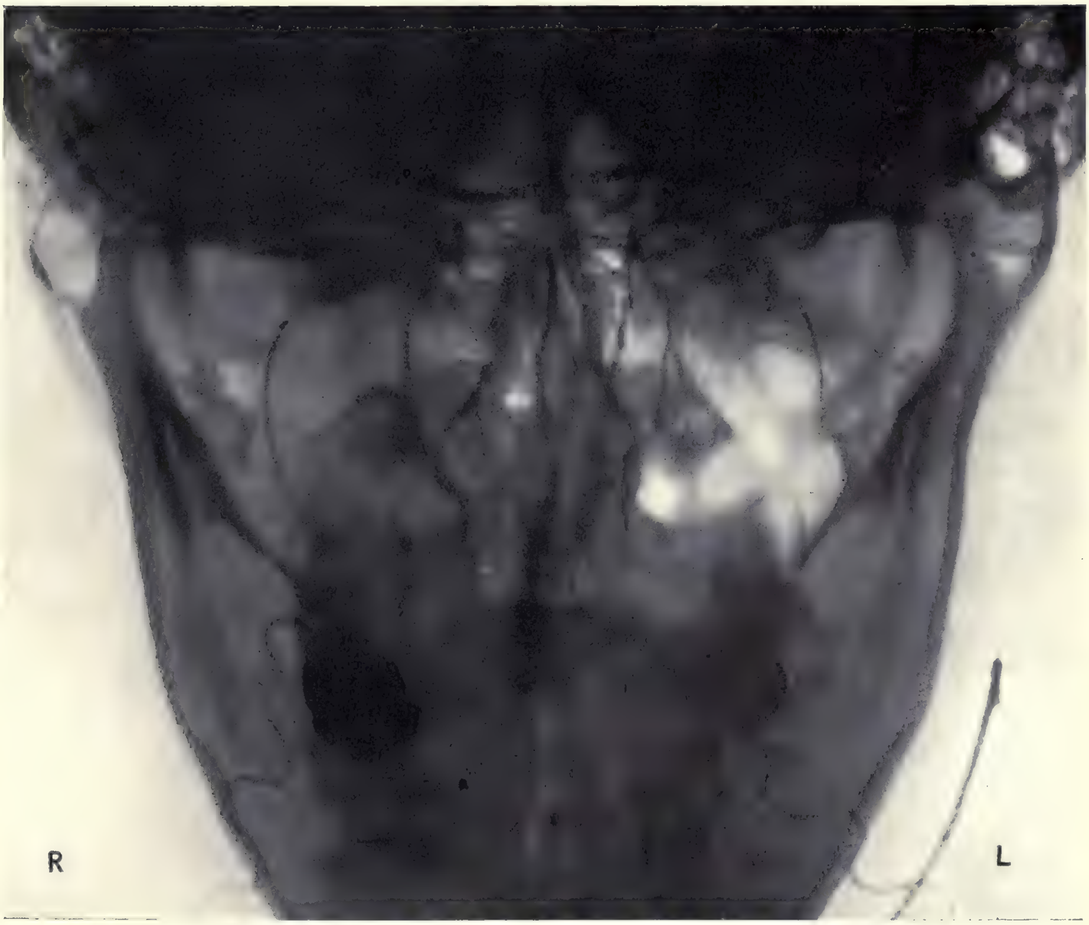


Fig. 2. Face, anterior view. Chronic disease of right antrum.

Plate 4.

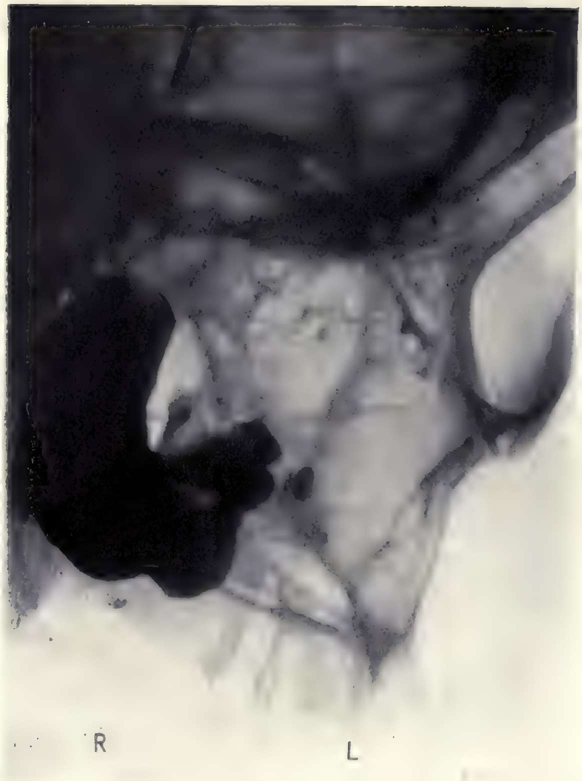


FIG. 3.
Adult skull, right antero-lateral oblique view. Right antrum partly injected with bismuth.

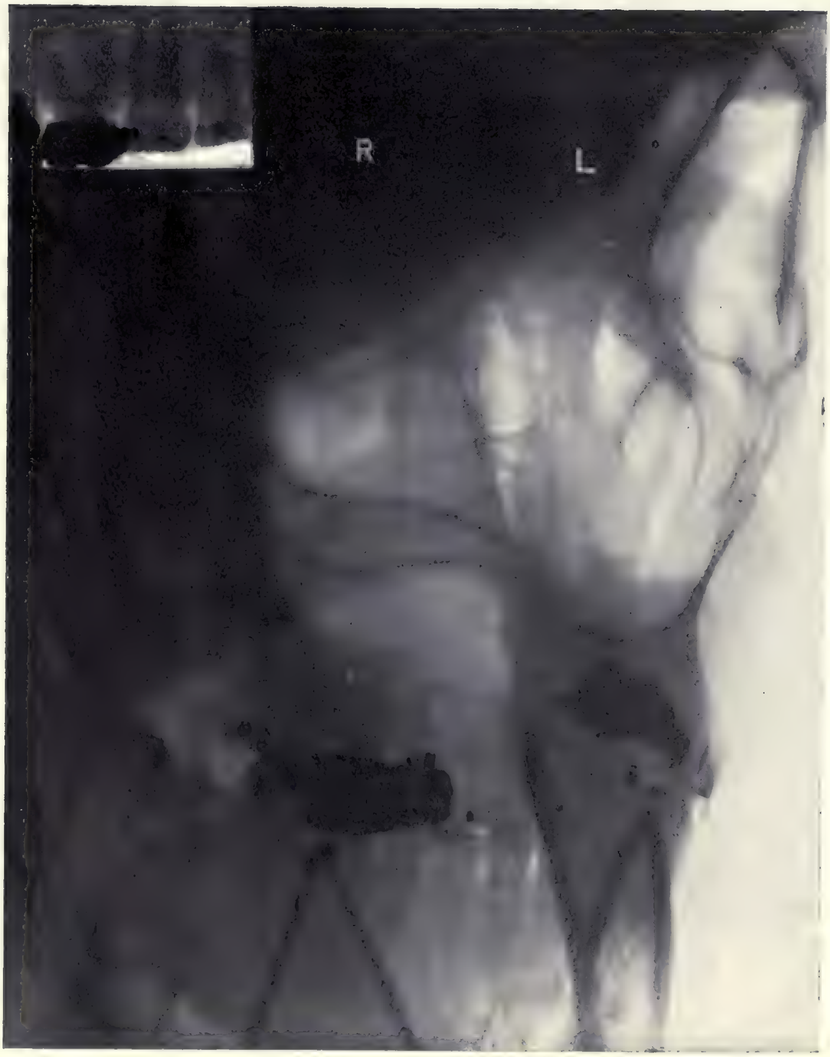


FIG. 4.
Face, right antero-lateral oblique view. Same case as Fig. 2.

FIG. 4A.
Molar teeth and second bicuspid, intra-oral view. Cavities around roots of second molar.

PLATE 5.

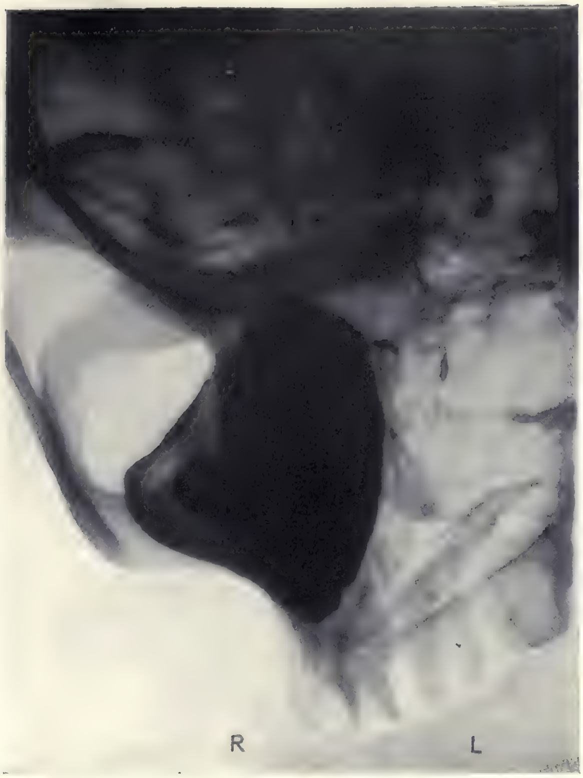


FIG. 5.
Adult skull, left antero-lateral oblique view. Right antrum injected with bismuth.

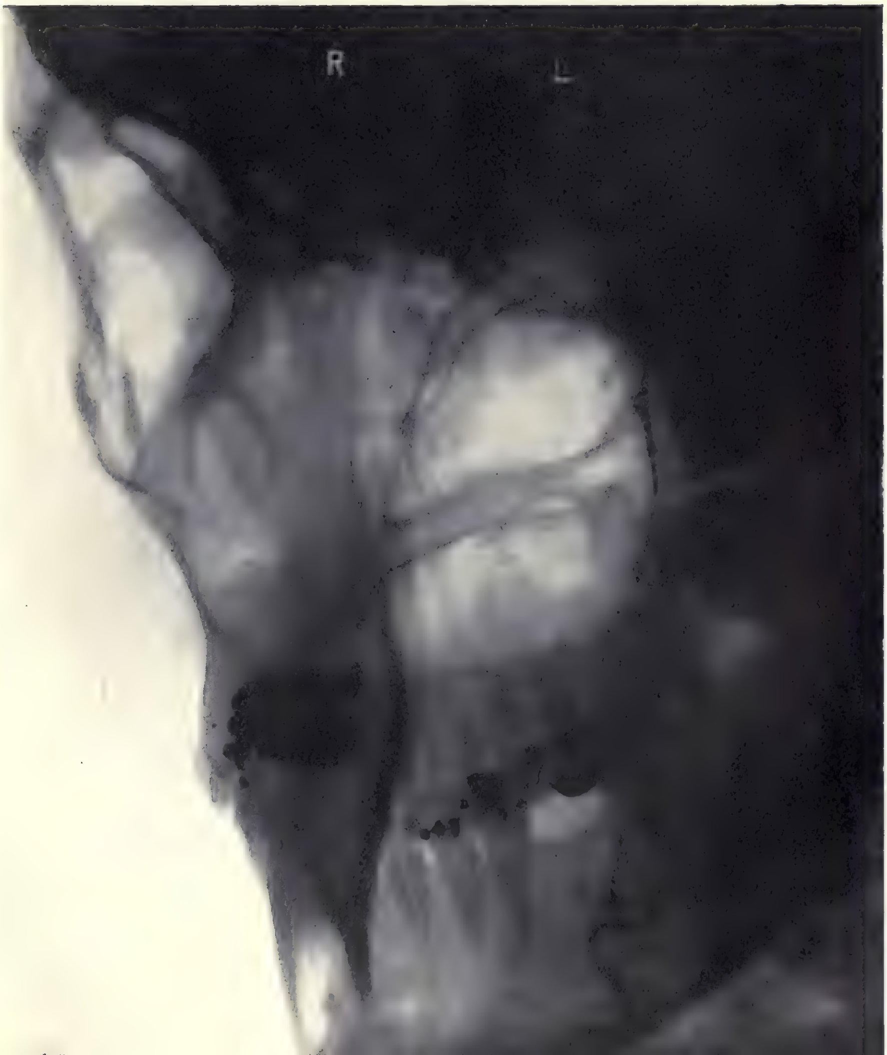


FIG. 6.
Face, left, antero-lateral oblique view. Same case as Figs. 2 and 4.

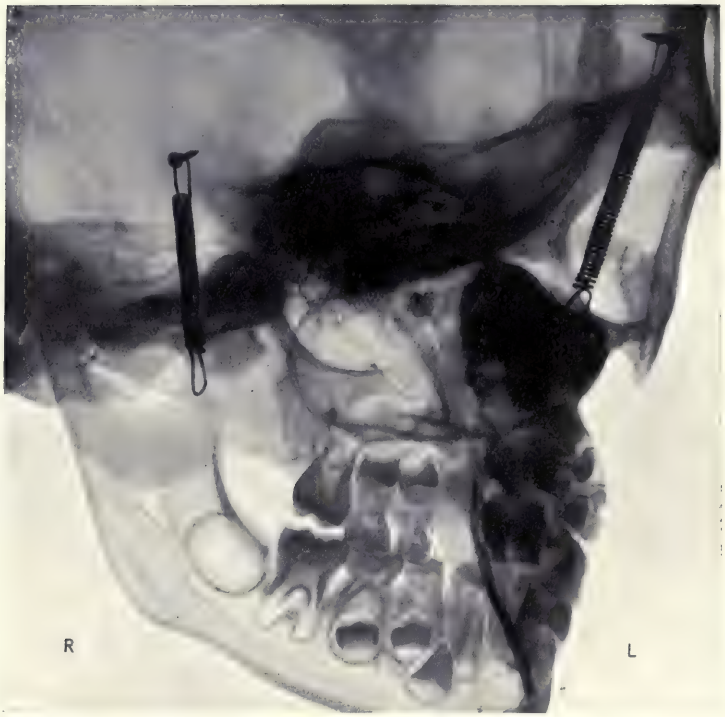


FIG. 7. Child's skull, right antero-lateral view. Left antrum injected with bismuth.

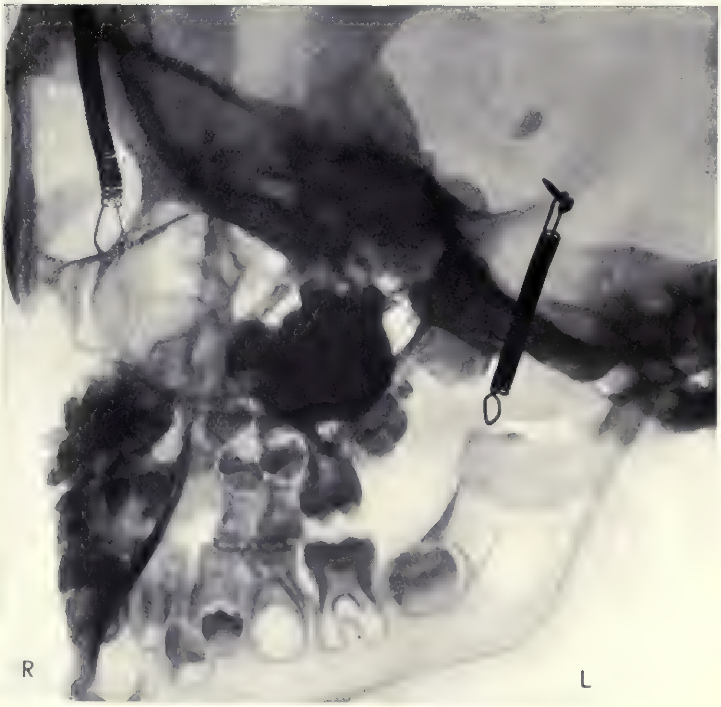


FIG. 8. Ib. Left antero-lateral view.

PLATE 7.

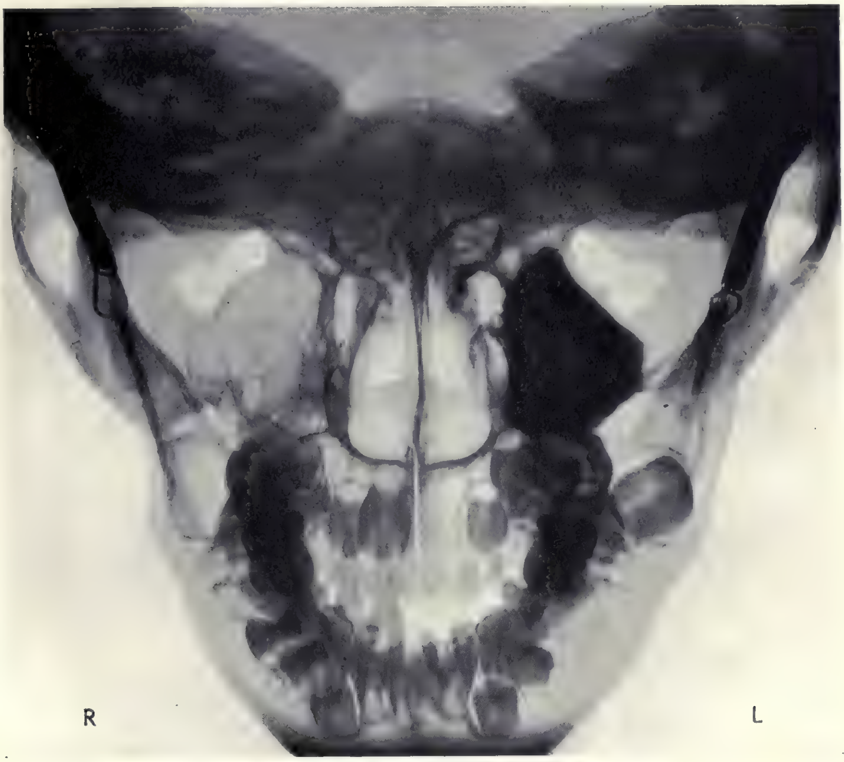


FIG. 9. Ib. Anterior view.

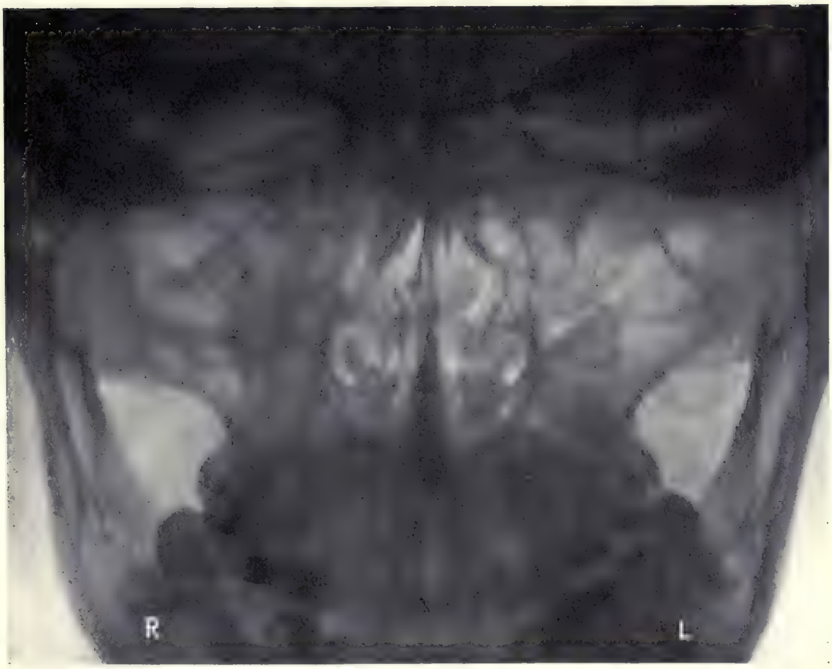


FIG. 10. Face, anterior. Right antrum contained sloughs and pus.

PLATE 8.

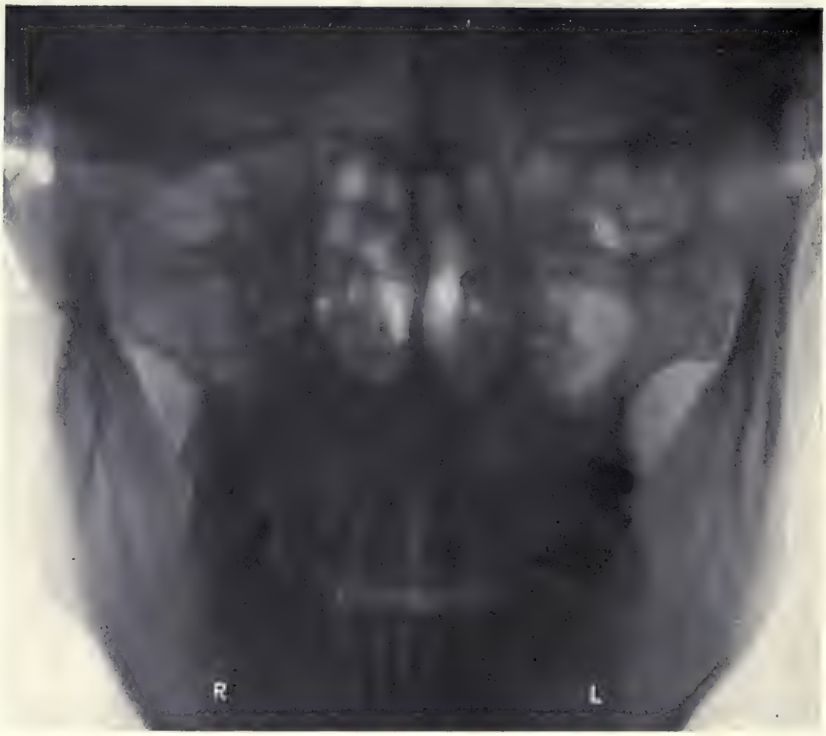


FIG. 11. Face, anterior. Right antrum contained polypi. Left antrum contained mucus. Left sphenoidal sinus contained polypi.

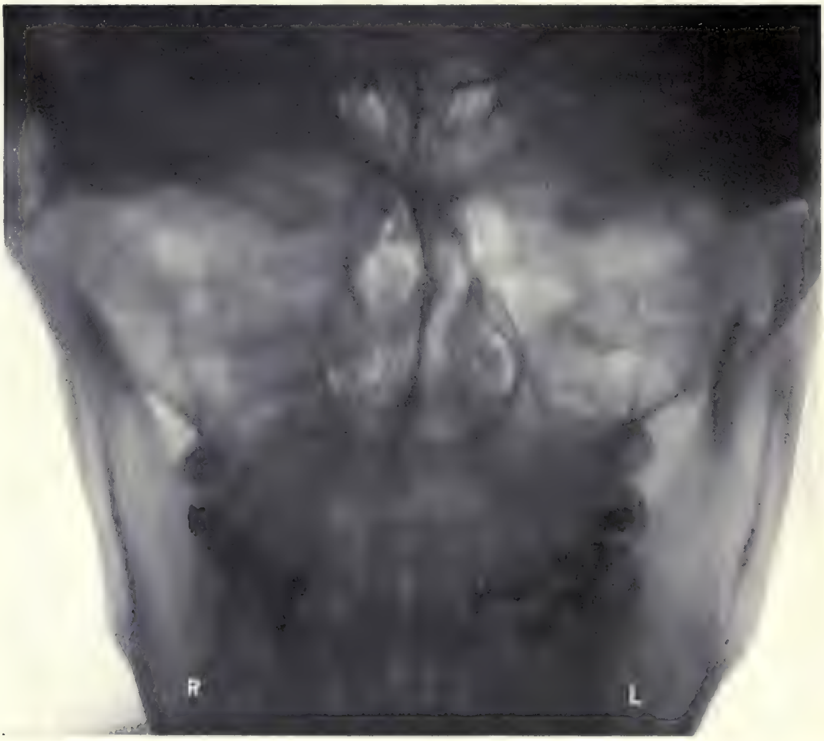


FIG. 12. Face, anterior. Right antrum contained an antro-choanal polypus and the left antrum mucus.

PLATE 9.

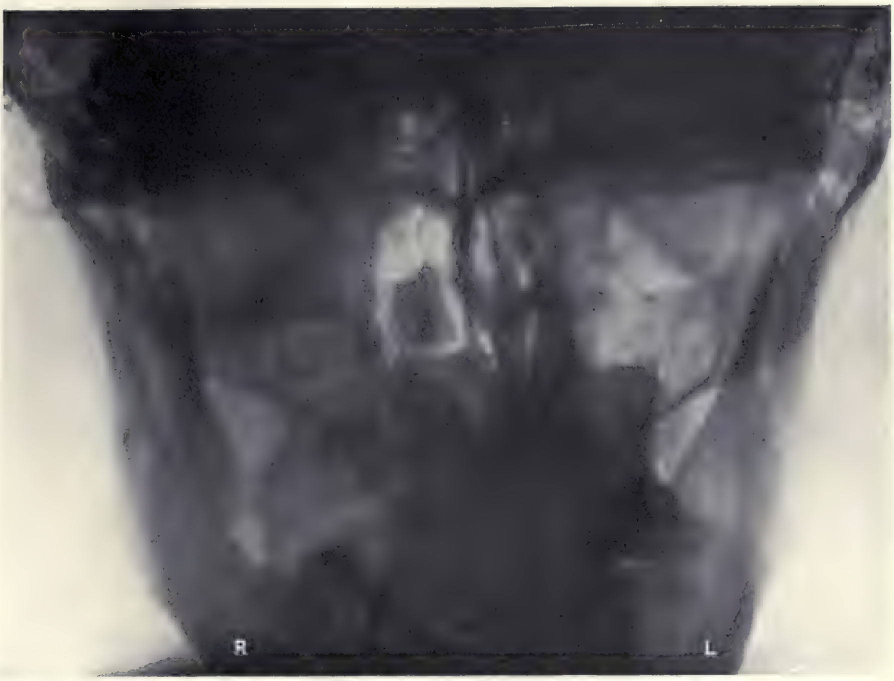


FIG. 13. Face, anterior. Right antrum has had a radical operation performed on it.

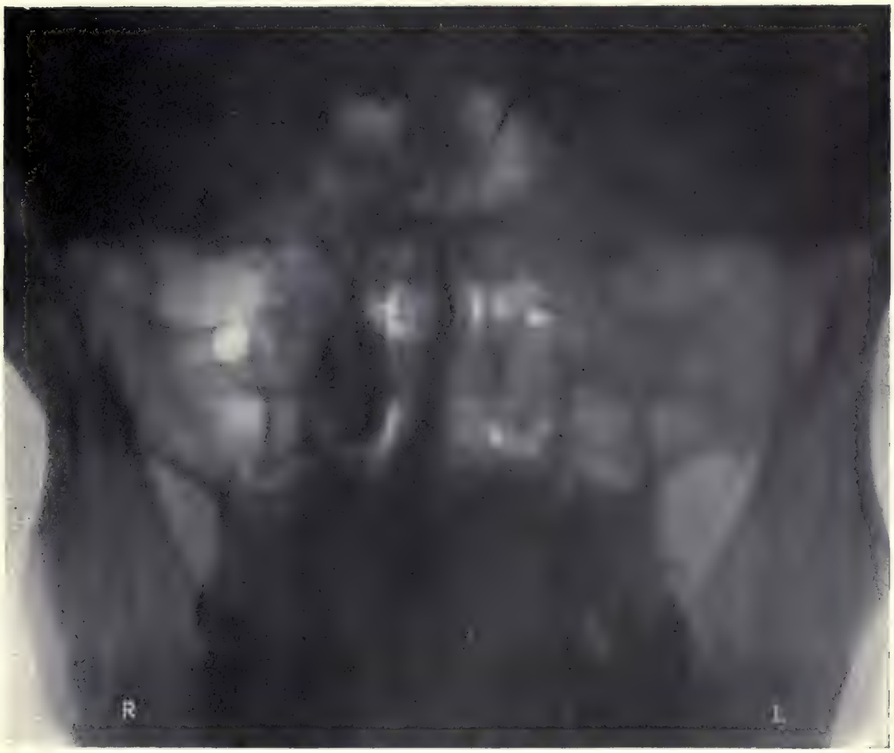


FIG. 14. Face, anterior. Left antrum has had a radical operation performed on it.

PLATE 10.

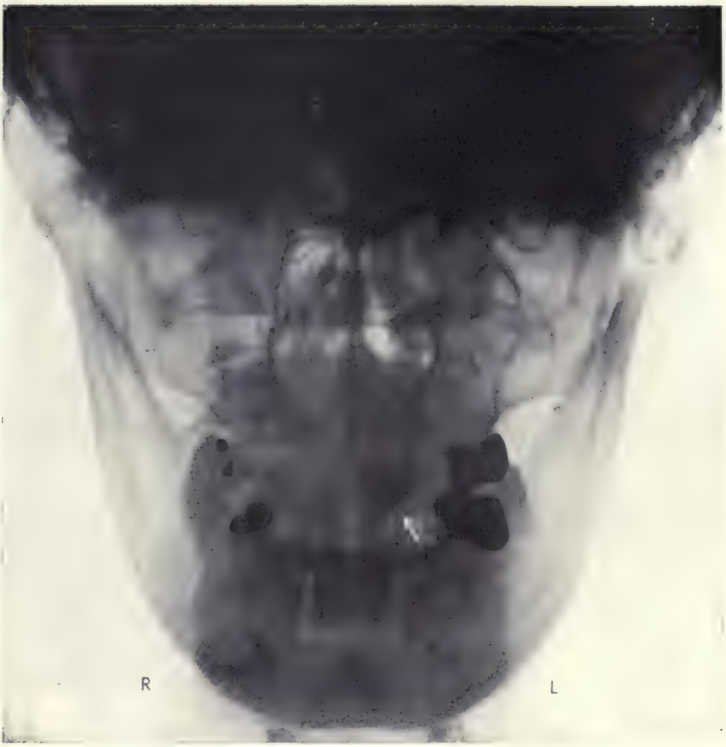


FIG. 15. Face, anterior. Left antrum contains mucus. Unerupted canine tooth.

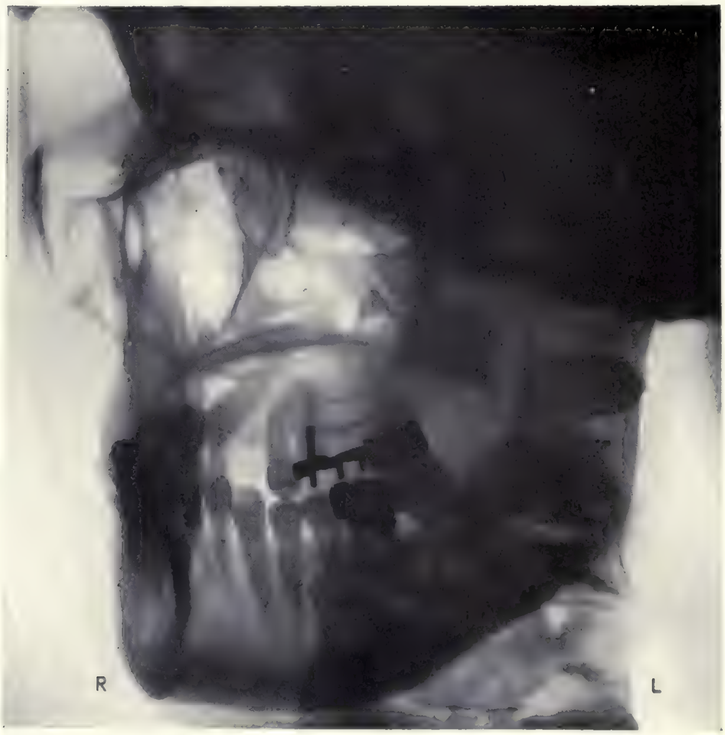


FIG. 16. Face. Left antero-lateral oblique. Same case as Fig. 15.

PLATE 11.

THE SABOURAUD PASTILLE AND X-RAY FILTERS.

By Agnes F. Savill, M.D., M.A.
Physician, London Skin Hospital.

Owing to absence in France on Red Cross work I have only now—June, 1915—had the opportunity of reading Dr. Sequeira's interesting experiments with filters and the Sabouraud pastille. In 1913 I made a series of observations on the changes of the pastille with different forms of filters, different thicknesses of filter, and different penetration readings of the tubes used during the experiments. Herewith I append tables showing my results. These were published in the *Lancet* and the *British Medical Journal*, which reported the proceedings of the Electro-therapeutic Section of the British Medical Association of 1913. In every experiment I used two pastilles—one on the top and one below the filter. I noted the milliampèrage, the Benoist penetration, spark-gap and time of each experiment, writing these on different sheets of paper daily, so that no subjective bias should prejudice the tests.

Table I.—*Registration of Pastille Measurements in Hampson Units.*
H = Hampson.

Date 1913.	Type of Tube.	Ma.	Benoist.	Spark Gap.	Time	Thickness of Aluminium Sheets.		
						0.4mm.	3 mm.	1 mm.
May 15	Small hard light anode	½	—	—	Min. 10	H 4* H 2+	H 4* H 1	
May 15	Water cooled heavy anode	—	—	—	12	H 3+ H 3	H 4 H 2—	
May 17	,,	—	—	6	—	H 4 H 3		H 7 H 4
May 17	Small hard light anode	—	10	—	9	H 5 H 4		H 5 H 3
May 17	Large light anode	—	—	6	15	H 4 H 3+		H 4 H 3—
June 2	Water cooled heavy anode	1	7	—	15	H 4 H 3	H 4 H 1	
June 2	Small hard light anode	1	10	—	8	H 5 H 4	H 5 H 1+	
June 6	,,	1	10	—	12	H 9 H 7	H 9 H 3	
July 4	,,	1	10	—	8½	H 5 H 3+	H 5 H 2	
July 6	,,	1	10	13	8	H 5 H 3+	H 5 H 2	
July 6	Large light anode	1	3	8	16	H 4 H 2	H 4 H 1	
July 6	Water cooled heavy anode	1	6	9	8	H 4+ H 3	H 4+ H 1	

---

* The top line in each experiment refers to the pastille placed above the aluminium filter, the bottom line to that placed under the filter.

TABLE II.—*Showing Penetration through Filters of Sodium Tungstate Lint and Felt.*

Pastille measurements in Hampson units.

Date 1913.	Type of Tube.	Ma.	Spark Gap.	Benoist.	Time	Screen of 12 layers Felt.	Screen of Lint.*	No. of layers of Lint.*
July 10	Water cooled heavy anode	2-1	–	4	Min. 7	H 3	H 1	8
July 10	Light anode	¾	8	7	10	H 4	H 3+	4
July 10	Light anode	¾-1¼	—	7-4	10	H 3	H 2	4

* Sodium tungstate lint.

TABLE III.—*Comparing Penetration of Filters of 3mm. Aluminium and Sodium Tungstate Lint and Felt.*

Date 1913.	Type of Tube.	Ma.	Spark Gap.	Benoist.	Time	3 mm. Aluminium.	S. T. Lint.*	No. of layers of S.T. Lint.*
July 12	Hard light anode	1	16	10	Min. 10	H 8 H 1+	H 8 H 1+	4
July 12	Hard light anode	1	16	10	—	H 6 H 1	H 6 H 1	4
July 14	Water cooled heavy anode	1	13	6	6	Simple Lint H 5 H 4	H 5 H 2	4
July 14	Hard light anode	¾	13	6 to 7	7	H 5 H 4	H 5 H 2	4

* Sodium tungstate lint.

These tables reveal that 0·4 mm. aluminium retards about one quarter, while 3 mm. retards less in proportion, only from three-fifths to one half. Bordier, employing chemical methods of measurement, found very different results—0·5 mm. allowed the passage of 55 per cent., 3 mm. allowed only 14 per cent. of rays. The tables also show that the penetration as registered by the pastille differed but little with hard and soft tubes, unless the degree of softness was very low indeed—2 or 3 Benoist. Twelve layers of felt were equivalent to four layers of sodium tungstate lint, and if that lint were very heavily impregnated, two layers would give the same retardation. Plain lint formed a very slight barrier to the passage of the rays.

SOME INJURIES CAUSED BY BULLETS

By Dr. Geo. A. Pirie, Dundee.

During the past eight months several hundred soldiers have been sent to the X-ray Room of the Dundee Royal Infirmary for examination. Most of these had wounds from shrapnel or bullets, especially the former.

I propose in this paper to deal with bullet cases alone and give examples of the nature of the injury, sometimes quite trifling, sometimes very severe, that a bullet may cause.

The simplest case was that of a soldier, E. D., age 38, who was struck on the right elbow by a bullet. There was a wound of entrance just behind the elbow, but no wound of exit, and on examination the bullet was at once seen lying not far from the point of entry. At the operation the surgeon easily found it under the tendon of the triceps and removed it. One curious point about the case is that the bullet must have entered broad end first. However, very little damage was done, and the man has now a useful arm.

Another case, where remarkably little damage was done, occurred in November, 1914, when Private H. Y., age 19, was struck by a bullet on the right side of the neck. Here again there was a small wound of entrance but none of exit. At the examination the bullet was readily seen, and to locate it two plates were exposed—one on the affected side of the head and the other on the face. From these it was inferred that the point of the bullet lay just behind the right tonsil and not far from the pharynx. At the operation the surgeon could feel the point of the bullet there, made a small incision and extracted it without difficulty. Recovery was uneventful. (See Fig. 1).

On the other hand, when a bullet travelling at full speed hits a bone the result is disastrous. The bone is usually comminuted at the spot and often split up for some distance beyond.

Four examples of this will suffice. H. H., age 30, was hit by a bullet in the right forearm on 30th October, 1914. The bullet passed straight through, but the radiogram shows the splintering of the ulna.

A more aggravated case is that of D. R., age 21, who was hit just above the right wrist on 2nd November, 1914. The bullet passed on, but the ulna was badly fractured, some of the pieces being carried onwards by the bullet. (See Fig. 2).

A similar course of destruction is shown in the radiogram of the right elbow of A. F., age 30, who was hit on 11th November, 1914. Both ulna and radius are fractured—the former being comminuted and the fragments carried forwards with the bullet. (See Fig. 3).

The last case I shall describe is a curious one, owing to the extent of the damage caused by the bullet. J. S., age 29, while carrying a wounded comrade on 30th January, was hit on the left leg. He fell and lay five hours before assistance could reach him. The tibia has been fractured in two places—the lower part being comminuted ; and the fibula also in two places, while fragments of bone are scattered through the soft tissues. In spite of so much damage, however, J. S. is now free from pain and is beginning to bear his weight on the injured leg. (See Fig. 4).

The occurrence of three simple fractures and one compound and comminuted as the work of one bullet is surely exceptional.

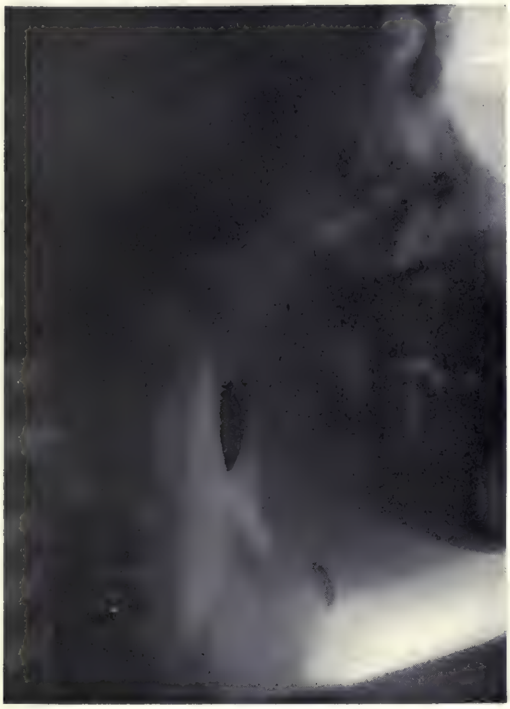


Fig. 1.—H. Y. Age 19.
Head. Side View.

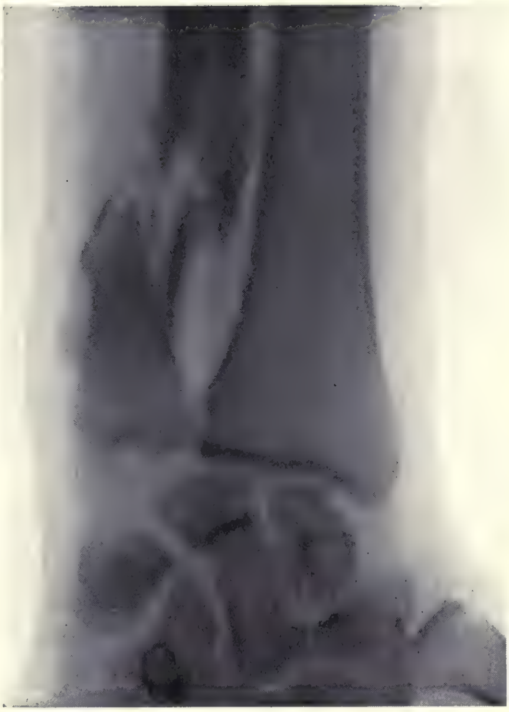


Fig. 2.—D. R. Age 21.
Right Wrist and Forearm.

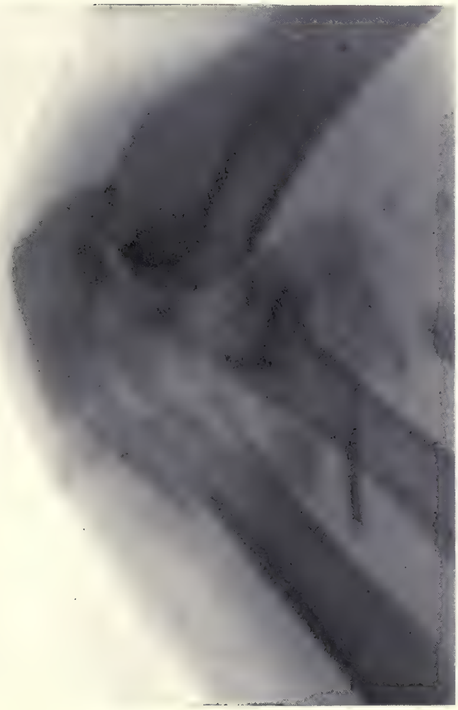


Fig. 3.—A. F. Age 30.
Right Elbow.

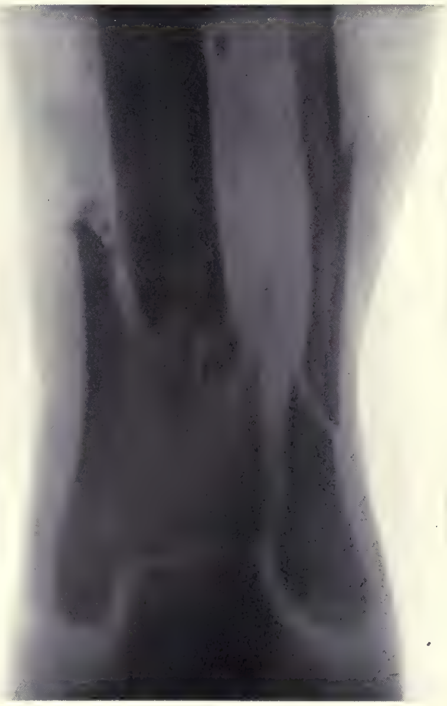


Fig. 4.—J. S. Age 29.
Left Ankle.

Plate 12.

REPORTS OF SOCIETIES.

ROYAL SOCIETY OF MEDICINE.

SECTION OF ELECTRO-THERAPEUTICS.

A meeting of the Section was held on Friday, 16th of April, under the presidency of Dr. Ironside Bruce.

THE LATE DR. H. LEWIS JONES.

DR. REGINALD MORTON, in proposing a resolution placing on record the great loss suffered by the specialty in the death cf Dr. Lewis Jones, and sympathy with Mrs. Jones, said that neither the old Society nor the present Section had ever met in a more gloomy mental atmosphere than on this occasion, for in the death of Dr. Jones the Section had sustained a loss which it could not make up. Dr. Jones was truly the father of electrotherapeutics, so far as the British Empire was concerned, and from the time he took charge of the Electrical Department of St. Bartholomew's Hospital the specialty took an upward trend. While in failing health Dr. Jones received a blow, from which he never recovered, in the loss of his son on H.M.S. *Hawke*. Dr. Lewis Jones had always been eager to help younger radiologists, and of his help to himself, the speaker, he could not give an adequate idea. Only those whose privilege it was to know the deceased somewhat intimately could realise what a great loss his death meant.

Dr. Cumberbatch, whose colleague at St. Bartholomew's Hospital Dr. Jones was, seconded the resolution. Soon after his introduction to Dr. Jones he realised that he was a keen physicist and an able physician, and when in difficulties that gentleman had been to him a kindly light leading him through the encircling gloom. Dr. Lewis Jones had been a prominent athlete, and was also a distinguished classical scholar.

The resolution was carried by members rising in their places.

THE STANDARD OPAQUE MEAL.

Dr. Reginald Morton read the report of the Sub-committee of the Section on a standard opaque meal for radiographic examination of the alimentary canal. The Sub-committee consisted of Drs. A. E. Barclay, A. F. Hertz, Reginald Morton, A. C. Jordan, and Mr. S. Gilbert Scott. Dr. Jordan did not subscribe to the main report, but submitted the separate report mentioned later. The report consisted of five heads:—

(1) The standard meal can consist of either bread-and-milk or porridge.

(2) The total bulk of the meal should be about half-a-pint.

(3) The meal should be mixed with two to three ozs. barium sulphate or bismuth oxychloride.

(4) The meal should be taken when the stomach is as empty as possible.

(5) No aperient or other medicine should be taken within thirty-six hours of the first examination, and if the bowels are not opened naturally an enema should be given on the morning of the examination.

Concerning the preparation of the bread-and-milk, two ozs. of white bread, devoid of crust, should be cut into small cubes. Eight ozs. of ordinary or malted milk are boiled in a separate vessel with two ozs. of bismuth oxychloride or barium sulphate. This is stirred and poured over the bread, sugar being added to taste.

If porridge be chosen, seven ozs. of finest oatmeal are mixed with two ozs. bismuth oxychloride or barium sulphate, and milk to bring the total to ten ozs., sugar to taste being added.

The following useful notes were appended:—

Bismuth carbonate neutralises about 22 per cent. of the free acids of the stomach, but there is no evolvement of gas, as the carbon dioxide is dissolved as rapidly as it is produced (H. Finnemore and A. E. Barclay). The reduction of the acidity of the gastric contents tends to reduce the motor activity of the stomach, and to interfere with the normal action of the pylorus.

Bismuth oxychloride is slightly more opaque to X rays than is bismuth carbonate (Reginald Morton).

Bismuth oxychloride is about one-and-a-half times as opaque to the X rays as an equal bulk, and twice as opaque as an equal weight of barium sulphate (Reginald Morton).

MINORITY REPORT.

Dr. Jordan's report stated that, in his opinion, the standard meal described was not suitable for the investigation of chronic intestinal stasis, and for this he recommended an emulsion containing four ozs. carbonate of bismuth with sugar of milk and water, to be taken within two hours after an ordinary breakfast, no purge or enema having been given. The details were given in the *British Medical Journal*, November 22nd, 1913.

Dr. A. F. Hertz said he thought it would be well to add a note to the effect that barium sulphate was very much cheaper than bismuth oxychloride, and therefore preferable for hospital practice, especially as it was practically equal from a radiographic standpoint.

Dr. Metcalfe asked whether suggestions had been made as to flavouring for the opaque meal, as he thought it should be made as palatable as possible, particularly as there was likely to be more disturbance when the meal was repugnant.

Dr. Jordan said the difficulty about flavouring was that it would be necessary to know, in advance, the patient's preference. He supported his contention in the minority report, and said there was occasion for two sorts of meal, one the ordinary solid mixture, and a smaller pabulum for the purpose of rendering opaque a meal already in the stomach.

Dr. Bailey thought many people would be found to prefer corn-flour to either bread-and-milk or porridge.

The President expressed the hope that members of the Section would all use the recommended meal, as it would be a great help in comparing results. Dr. Hertz's suggestion he regarded as an excellent one.

Dr. Reginald Morton replied that the intention of the Sub-committee was not to set forth details, but to suggest a basis. He agreed that everything possible should be done to render the meal as little objectionable as possible. With regard to the comparison of bismuth oxychloride and barium sulphate, he would be glad to see the former left out, so that barium should be employed only. He had had some cases in which barium seemed to accelerate the meal's digestion, but there seemed no reason against using it for every case.

Dr. Hertz showed slides illustrating the following conditions:—

(1) Achalasia of the cardia.

(2) Syphilis of the stomach.

(3) Appendicitis with undescended cæcum.

(4) Appendicitis with colon situated entirely on the left side of the abdomen.

(5) Heart pushed over to the right side of the chest by splenic flexure.

(6) Hirschsprung's disease in an adult without symptoms.

(7) Tracings showing result of treatment of atonic dilatation of the stomach.

(8) Tracings showing result of treatment in severe intestinal stasis and coloptosis.

The President commented on the hopefulness engendered in one's mind by such an instructive series of cases, bearing in mind the severity of the operation for stasis in the intestinal canal.

Dr. Hernaman-Johnson mentioned, as an alternative when the patient was not able to lie up, the efficacy of rhythmic stimulation of the abdominal muscles by the sinusoidal current, or faradism interrupted by means of the metronome. One could combine that with paraffin or cascara and supports, or not. Such treatment over a course of six or eight weeks resulted in a cure, for three years afterwards there had been no recurrence.

Dr. Barclay expressed his agreement with the remarks of Dr. Hernaman-Johnson.

Dr. Reginald Morton agreed, and laid stress on treatment with a very slow alternation, about one per second, as the rate of contraction of unstriped muscle, especially when it had lost some of its tone, was very slow. He, like the President, was much encouraged by the series of cases which Dr. Hertz had shown, as such medical means would do much to reduce the number of persons who would undergo the severe operations for intestinal stasis.

Dr. Alfred C. Jordan read a paper on "Glycosuria in Chronic Intestinal Stasis." In the experimental methods of producing glycosuria three facts stood out prominently: (1) Claude Bernard's "diabetic puncture" of the floor of the fourth ventricle of the brain; (2) the administration of certain drugs, especially phloridzin; (3) extirpation of the pancreas. The last of these threw by far the most light on the ætiology and pathology of diabetes mellitus, though, so far, we were still without a specific cure for the disease. But the knowledge of the relation of the pancreas to persistent glycosuria was leading to important pathological and therapeutic results. The pancreas was not at fault in every case of diabetes, though it was found to be diseased in 75 per cent. of the cases examined post-mortem. Nor was pancreatic disease always accompanied by glycosuria. If all but one-fourth of the pancreas were extirpated, there was no glycosuria. With regard to the pancreatic function in relation to chronic intestinal stasis, the undue retention of intestinal contents in the lower coils of the ileum led to their invasion by microbes from the cæcum, and as these coils were almost sterile in health, they could not deal with large doses of bacterial toxins, hence there was set up a general toxæmia. These overloaded coils constantly pulled upon the mesentery when the person was in the upright posture; a thickening might form at the point of greatest tension, the commencement of Lane's "ileal kink." Instead of that, however, in a feeble patient the mesentery yielded, and its attachment to the posterior surface of the abdomen slipped down, and a kink was produced at the duodeno-jejunal junction, and behind this kink the duodenum was distended. This, and the exaggerated duodenal peristalsis were apparent with X rays. The congested duodenum was later invaded by bacteria, probably resulting in ulceration, or infection of the gall-bladder *via* the common bile duct. One of the results of the succeeding general toxæmia was, in women, a mastitis of nodular form, which later proceeded to chronic cystic disease, and might eventually become cancerous. Chronic pancreatitis was another sequel; and both cleared up with the relief of the stasis. Most subjects of glycosuria suffered from chronic intestinal stasis. The urine contained indican, xanthin bases and tyrosin; and one of the first indications in glycosuria was to relieve the chronic constipation. Transitory glycosuria was also often present in subjects of rheumatoid arthritis and in dyspeptics. The author concluded by mentioning cases in illustration of his thesis, and showed an instructive series of skiagrams.

Dr. Barclay showed skiagrams and narrated a case of simple peptic ulcer of the œsophagus in a girl, and its successful treatment by ionization. He also showed pictures of a number of interesting conditions.

RÖNTGEN SOCIETY.

An interesting discussion was initiated by Dr. N. S. Finzi at the meeting of the Röntgen Society on April 20th, the subject being that of late burns occurring after X-ray and radium treatment with filtered rays. Dr. Finzi described very fully three remarkable cases which had come within his experience, the late reactions taking place a considerable time after the original exposure. In two of the cases the reaction was erysipelatoid in appearance; in the other it seemed to have more of a teleangiectatic character. Dr. Finzi cited the historic paper of Speder in *Archives d'électricité médicale* of 1912, and bore out the Frenchman's conclusions in certain respects, though not in all, for whereas Speder stated that these late reactions tended to occur in parts, such as the lower abdomen, where the skin was less well nourished, the worst of Dr. Finzi's cases was one in which the trouble took place over the root of the neck and the upper part of the thorax, both of which regions are well supplied with blood. The late X-ray effects do not occur with unfiltered rays unless a burn has been produced, but, unfortunately, it is just these penetrating rays responsible for the trouble which are of therapeutic value, and their use cannot be abandoned. Dr. Finzi urged strongly that this condition of reaction was a rare one, and that radiologists would not be justified in diminishing the necessary treatment of the very grave conditions they were called upon to deal with from fear of this rather remote danger. The use of thicker filters was a great safeguard—filters of 3·6 mm. were now ordinarily employed, whereas at one time filters having a thickness of only 0·75 mm. were frequent. Nevertheless, one of his three cases of X-ray reaction was treated with this thick filter.

Sir A. P. Gould, who presided, said that he had no case of late reaction to bring forward, but he endorsed Dr. Finzi's plea that this occasional trouble must not be allowed to tie their hands. Dr. Robert Knox said that in the course of his experience he had seen such cases, and had attributed them to defective technique, but of recent years the technique had been greatly improved. A harder tube was used than formerly; the soft rays were filtered out with thick layers of aluminium (3 mm.) placed half way between the tube and the skin surface, and he insisted also at the Cancer Hospital upon the use of secondary filters in the shape of lint or a loofah sponge. These precautions had largely eliminated the cases of reaction. The latest he had seen was a case in which X rays had been applied for sweating palms, with good immediate results, but followed by the development, three years later, of tingling in the area treated, and subsequently by teleangiectasis of a very marked type. Dr. G. B. Batten was of opinion that in two of Dr. Finzi's cases arsenic, which had been used as an injection, had depressed the vitality of the tissue cells, and possibly had led also to the production of secondary rays, so that the untoward result was due to the combined effect of the two agents. Dr. F. L. Provis said that he had been carrying out the Freiburg technique for women, the rays being directed through perhaps twelve ports of entry in one sitting, and as yet, after eighteen months' work, he had never seen more than a slight brownish pigmentation. Dr. Finzi, in reply, gave reasons for thinking that in his own cases arsenic had no influence as a cause of the reaction. The question of sickness, he said, had been brought forward, and to avoid this, in abdominal cases, he had spread the exposure over three days. There was almost invariable sickness if large doses of X rays were given upon the liver.

Mr. F. H. Glew then read a paper in which he described a new alpha ray effect. A thin sheet of mica—a sheet so thin that the range of the alpha particle in air was reduced by about one-seventh part only—was placed over a radium capsule, and although the mica was originally flat, it became within a short time—*i.e.*, a few weeks—curved, the curvature being produced only over the part representing the radio-active area. The curvature was always towards the radiated surface. This phenomenon occurred uniformly however the strips were cut from the mica. If the sheet of mica was too thick to bend, then internal stress was produced. The effects persisted through a great range of temperature, and Mr. Glew thought that the alpha rays alone must be the cause of this mechanical effect, though the precise nature of their action had still to be determined. Professor A. W. Porter said that it would almost appear as if the alpha particles were themselves strong enough to stress the plate. Mr. H. J. Gardiner was of opinion that the curvature was due to helium atoms being occluded in the under-surface of the mica, and suggested that the mica be heated, and the residual gas given off examined spectroscopically.

Mr. A. O. Forder showed an ingenious form of plate-holder and masking device.

THE MEASUREMENT OF ELECTRIC POTENTIAL AT A DISTANCE WITHOUT ANY INTERVENING WIRE.

Comptes Rendus, t. 158. p. 561.

By M. B. Szilard (Paris).

When a highly charged body is placed near an insulated conductor at the potential of the earth and the intervening air is strongly ionized, the body loses part of its charge. There is a sudden disturbance of the lines of force in the neighbourhood and the insulated body attains a potential far in excess of that corresponding to the intensity of the electric field at the same distance from the charged body in non-ionized air. This phenomenon has enabled me to devise a practical means of measuring electric potential at some distance, without the use of any connecting wire.

If, in the above experiment, the insulated conductor consists of a metal plate connected to an electrometer, the readings of the latter will, under suitable conditions, enable one to estimate the potential of the charged body. The potential shown by the electrometer and the rate at which equilibrium is established will depend on the actual potential of the charged body, its distance from the insulated plate, the intensity of the current carried by the ionized air, the capacity of the measuring instrument, and lastly the ratio of the ionic current from the charged body to the electric leak of the measuring apparatus

I would make clear at once that the principle of this method is by no means identical with that of the ordinary device for measuring atmospheric electricity. In the latter we find the potential at a given point by placing the potentiometer plate at that point. We therefore make use of a radio-active substance which only emits alpha rays (polonium), so as to avoid any disturbance of the electric charge. The present problem, on the contrary, is to deduce the potential of a distant body from direct observations of the potential of the receiving plate placed at some known distance from that body. This method requires the use of penetrating beta and gamma rays rather than of short-range alpha rays.

In my apparatus I use a metal disc coated with a strongly radio-active substance, which serves the double purpose of ionizer and potentiometer plate. This plate is attached to an insulated support and connected to a direct reading electrometer which indicates immediately the potential of the plate.

a divided scale. Its capacity is of the order of six electrostatic units, and the whole capacity of the apparatus is only some fifteen such units.

Mode of Action.—The apparatus, *i.e.*, the receiving plate on its stand, and the electrometer with some 50 cm. of wire between them, should be placed as far as possible from all other objects. The following experiment may then be made. Rub a piece of ebonite, or sealing wax, and hold it some 30 cm. from the receiving plate. The electrometer needle will be deviated to the extreme limit of the scale, indicating 350 volts. This same experiment may be repeated at a greater distance, up to 60 cm., by using amber or celluloid instead of ebonite, whilst with a small induction machine we shall get a result at a distance of several metres, if one pole of the machine be earthed. A Ruhmkorff coil or an high tension transformer will give the same effect if some means be taken to render the current unidirectional.

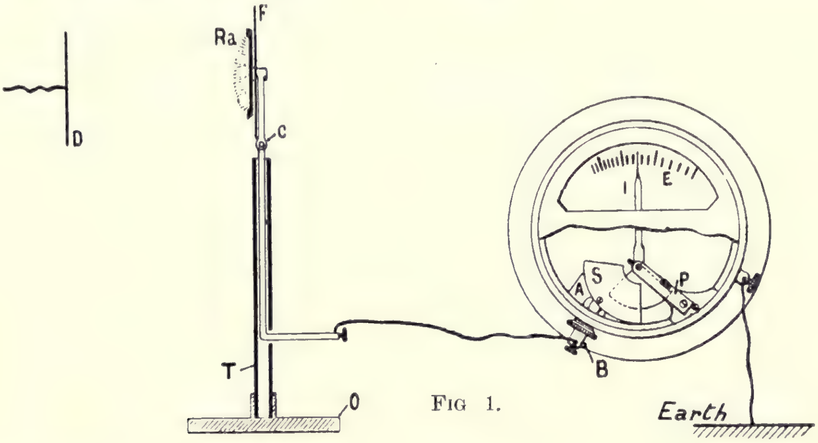


FIG 1.

Description.—The potentiometer plate is a metal disc carrying a screen (RA, Fig. 1), 48 mm. in diameter, containing a definite measured quantity of pure radium. This disc is screwed to another metal plate, F, 90 mm. in diameter, which is attached to a jointed metal rod, C. The metal rod is supported in an ebonite tube, T, 180 mm. long, which is fixed in the metal base, O. The rod, C, is thus completely insulated, its lower end being connected with the terminal of the electrometer by a fine wire several yards long.

This electrometer, which has already been described in the ARCHIVES (Vol. XIX, p. 3), is of very small dimensions, and has a rigid needle which indicates the voltage directly on

The electrification by friction of the ordinary leather driving belts of machinery can be demonstrated at a distance of a metre or more, as can that of any machinery in which the moving parts are of insulating material, as in the textile industries. Finally, at a distance of 20 or 30 cm. we get successful results by simply rubbing a piece of paper between the fingers, or stretching a piece of textile material. Silk and wool thus tested exhibit strong electrification; when entering a factory with this apparatus the needle will show a marked deviation whilst still some metres from the site of operations.

Interpretation of the Indications under Varying Conditions.—If we take a metal plate, D (Fig. 1), 160 mm. in diameter, and charge it to different potentials from some constant source of electricity, such as a battery of accumulators, we can vary its distance from the receiving plate, Ra, and tabulate the electrometer readings thus obtained. The following is such a table:—

I.

Potential (positive) of plate D = 950 volts.

Distance between D & Ra.	Voltage indicated.
15 cm.	705 volts
20 ,,	500 ,,
25 ,,	380 ,,
30 ,,	315 ,,
35 ,,	275 ,,
40 ,,	250 ,,
100 ,,	45 ,,

II.

Distance between D & Ra = 30 cm.

Potential of D.	Voltage indicated.
950 volts.	315 volts.
750 ,,	255 ,,
550 ,,	195 ,,
350 ,,	130 ,,
150 ,,	50 ,,

We see from the above that at a distance of one metre the electrometer will still indicate $\frac{1}{20}$ of the actual potential of the observed body.

By varying the dimensions of the plate, D, we alter the observed values. Thus a plate charged to 750 volts and placed 25 cm. from the receiving plate will give a reading of 300 volts if the plate is 160 cm. in diameter, but this will fall to 240 volts if the diameter be only 94 cm. Again, at a distance of 30 cm. the large plate will give 255 volts and the smaller plate only 200 volts.

The accuracy of the indications given is surprising—they can be repeated with an error of less than 2 per cent. The values given above were obtained with only ·1 milligramme of radium bromide spread on a screen 48 mm. in diameter. This quantity is sufficient to give a state of equilibrium in about two seconds, even when the distance is relatively great (100 cm). The electrometer needle is very completely damped.

If the receiving plate be covered with a thin plate completely absorbing all alpha rays, there is hardly any appreciable change in the readings, showing that the result is almost exclusively due to the beta and gamma rays.

Applications.—The above method may be used with advantage for the measurement of high potentials, since it enables these to be determined from a distance, without any contact with the conductor. The arrangement also enables one to detect any electric leakage. It also permits us to determine the electric potential of insulators and of rotating bodies which cannot be put in direct electrical contact with any measuring instrument.

REVIEWS.

Medical Electricity, Röntgen Rays and Radium. By SINCLAIR TOUSEY, A.M.M.D., Consulting Surgeon to St. Bartholomew's Clinic, New York City. Second edition, thoroughly revised and greatly enlarged. 8vo, 1,219 pages, with 798 illustrations, 16 in colour. Price 35s. net, cloth. W. B. Saunders Coy., Philadelphia and London.

A second edition of Sinclair Tousey's well-known work on medical electricity, Roentgen rays, phototherapy, and radium has now appeared. More than 100 new pages have been added, while fifty new illustrations bring the total number of the latter to 801. The work of the author in including within this encyclopædia—for as such it may rightly be described—the advances that are continually being made in subjects that are ever extending their boundaries, has been no light task, but the reader who seeks for information on any important new work will find it in this edition. There is a description of the method of testing the reactions of muscles by condenser discharges. The double pole switch described for charging and discharging the condensers is not so suitable as the metronome, with silver wires dipping into mercury. In the account of the abnormal electrical reactions of muscle, the author notes that degeneration does not always produce polar reversal—a fact that is not yet sufficiently recognised.

That very important new form of electrical treatment — diathermy — receives due consideration, and reference is made to a number of diseases for which it may, with advantage, be applied. Its use in surgery might have been more fully described.

Much new information has been added on the action and use of sinusoidal currents. The string galvanometer is described, and some electrocardiograms are shown.

The section on X rays contains 475 pages. The value of that part dealing with X-ray diagnosis would be still further increased by adding more skiagrams of the normal taken in standard positions. The Coolidge tube is described. The section on treatment is very inclusive. Although the experience of other workers is quoted, the reader will find descriptions of technique or suggestions of methods for the radiotherapy of different diseases. The Gauss method of X-ray treatment of uterine fibromyomata is described, but the author recommends caution in trying it.

There is a good general account of the results that may be expected when the X rays are used in the treatment of malignant disease.

Radiumtherapy and phototherapy are fully treated.

In conclusion, it may be said that although the expert on any portion of the subjects of the work under review may find matter for criticism, he will find information on every branch and subdivision of medical electricity, radiology, phototherapy, and radium, and the author's original investigations, which are everywhere evident. There is an admirable index.

X Rays: How to Produce and Interpret them. By HAROLD MOWAT, M.D. Edin. Pp. 204. Oxford Medical Publications. Oxford University Press.

The author states in his Preface that this book is intended for those who have little or no knowledge of the subject of X rays. He describes the elements of the subject in a clear and simple manner, but confines his attention to radiography, deeming the subject of radiotherapeutics worthy of a separate volume; we do not gather whether it is the author's intention to supply this extra volume, but we may hope that he will feel encouraged to do so. In saying this we would not suggest that the volume before us does not in some respects invite criticism, but rather that the scheme of the book is a good one; it is essentially a book for the beginner, a book easily read and well illustrated. There are some inaccuracies to be found in these pages, many of which it is only rational to suppose would have been deleted had not the exigencies of the times demanded other services from the author.

Chapter I. is devoted to a description of X-ray tubes and their vagaries. In discussing the gradual hardening of tubes, the author states that the cause is two-fold, viz.: "In the first place the passage of electricity tends to separate small particles from the anticathode due to inverse current, and by forming them to absorb electrons, and secondly, the escaping electrons pierce the glass, thus raising the vacuum. At the same time, however, overheating is bound to occur if a tube is used continually and the electrons in the metal are released, and tend to lower the vacuum." The author is evidently under the impression that the electrons are important in this process of hardening, but, although the details of the process are still obscure, it is probable that the gas within the tube plays a more important *rôle* than any liberated electrons. On the following page, in contrasting the radiation emitted by a soft and a hard tube, it is stated that from the former the rays are of short wave-length, and that from the latter the wave-length is considerable. The impression is conveyed that with increasing hardness the wave-length is increased, whereas the reverse is true.

Chapters II. and III. are devoted to a consideration of the chief sources of supply by means of which X rays are produced. In describing the way in which the continuous current from the main is used to work an induction coil, the text does not accurately describe the system illustrated in Fig. 6, and the paragraph on p. 27, defining a condenser as "an apparatus consisting of two large-surfaced insulated conductors placed near each other, so that if one is connected to earth it will charge the other with an increased electromotive force," does not give a correct description of the function and mode of action of a condenser.

Chapter IV. is devoted to the accessories of X-ray outfits, considerable space being devoted to a description of the different types of X-ray couches, and some details of the fluorescent screens in ordinary use.

Chapters V. and VI. complete Part I., and are devoted to the description of methods of localization of foreign bodies and the technique of the development of radiographs. The description of the more general methods of localization concludes with a new method which has been devised for the case of a foreign body in the eye, and which consists of a thin disc-shaped prothesis which fits the surface of the eyeball. It is sufficiently opaque to the rays to be visible by screen examination, and since it moves with the eye, any change of position of the foreign body relative to the eye may be demonstrated.

Part II. deals with the interpretation of radiographs, and this takes up the remainder of the volume. Commencing with the thorax, the author briefly describes the methods of examination employed. The skiagrams have been selected mostly with a view to their diagnostic value, and include good examples of phthisis, empyema, and cardiac disease.

The digestive tract is next dealt with, and this chapter is illustrated by a number of interesting conditions met with in routine examinations. In dealing with the urinary system the author is somewhat vague on one or two points. For instance, on p. 145, the method adopted for the radiography of the kidney region is thus described: "The second radiogram is taken in the antero-posterior position, and shows the renal regions and the upper part of the ureters on both sides." The interpretation to be made is that the plate is placed on the anterior abdominal wall, the tube being centred over the second lumbar spine. This position is, of course, a recognised one, but it is not the usual and certainly not the best method to employ for the kidney region. Again, on p. 146, we read: "It is important that no part of the ureter should be missed, and that the top of the iliac crests should appear in both radiograms, as the part of the ureter which passes over the region is frequently the seat of a calculus." There appears to be some ambiguity here, and the anatomical relationships kept insufficiently clear.

The book concludes with two chapters on bones and joints, and some good radiographs illustrate cases of injury and disease to various parts.

This book should prove especially useful to many of the X-ray operators now engaged in military work, for the information is put in a concise manner, and deals in general with conditions frequently met, and occasionally with the rarer and more difficult cases.

NEW INSTRUMENTS.

AN IMPROVED METHOD OF LOCALIZATION OF FOREIGN BODIES BY MEANS OF X RAYS.

By G. G. Blake, Radiographer to the Royal Hospital, Richmond.

In order to obtain sufficient data from which to calculate the exact position and depth of a bullet or other foreign body by this method it is necessary—

(1) To make two exposures (on the one plate), the tube being moved a distance of several centimetres before the second exposure is made.

(2) To know the exact point on the plate over which the tube was when each exposure was made.

(3) To know the distance between the two shadows of the foreign body on the plate.

(4) To know the exact distance the tube was moved between the exposures.

(5) To know the height of the X-ray tube from the plate when these exposures were made.

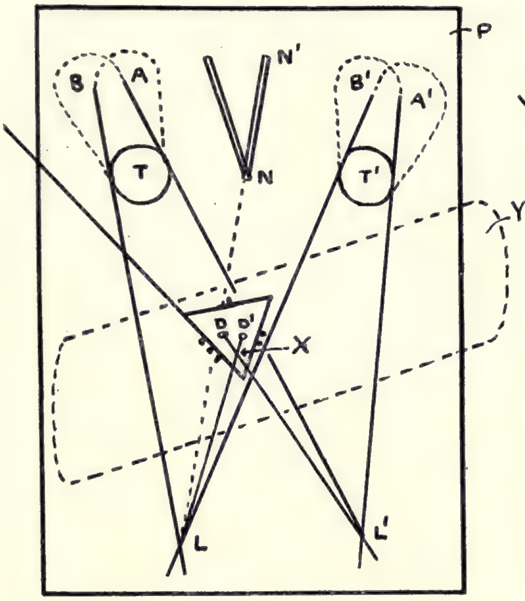


Fig. 1.

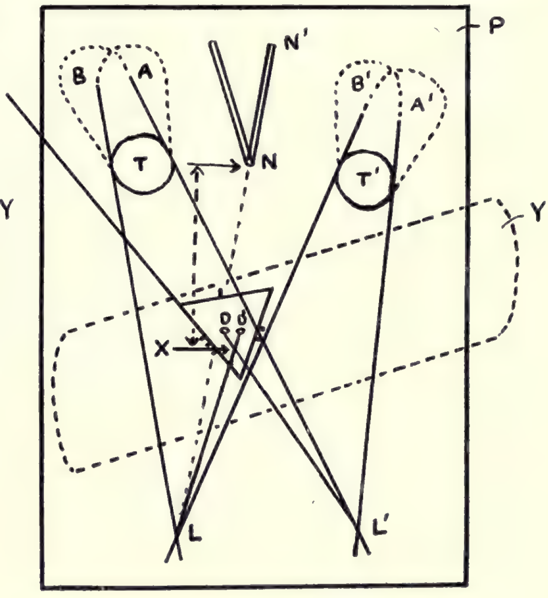


Fig. 5.

By the use of the following method all these factors can be determined after the radio has been taken, directly from the negative (or print), rendering it unnecessary to make *any* preliminary measurements, the plate forming a self-registered record of all necessary data.

The only apparatus required are any X-ray tube, supported by any form of tube holder, one X-ray plate, a localizer, and a small metal triangle or "marker."

The localizer, which was made to my design by the Medical Supply Association, consists of a block of wax or other material transparent to X rays, in which are embedded two small metal cylinders, T and T^1, about 6·5 centimetres apart, and half way between them, also embedded in the wax, is a height-finding needle ten centimetres high.

The triangle, the sides of which are marked 1, 2, and 3 (as shown in Fig. 1 and Fig. 5), is made of wire, and for convenience one of its sides is extended to form a handle.

The procedure is as follows:—

The localizer is placed at one end of the X-ray plate, P (Fig. 1), so that the height-finding needle and cylinders are perpendicular to the plate. The triangle having been moistened with a solution of silver nitrate, or ink, is placed below the patient, Y, on the plate, the X-ray tube is now placed anywhere above the plate, preferably on the side of the plate furthest from the localizer, and an exposure made; it is then moved any distance across the plate, and a second exposure made on the same plate without moving the patient.

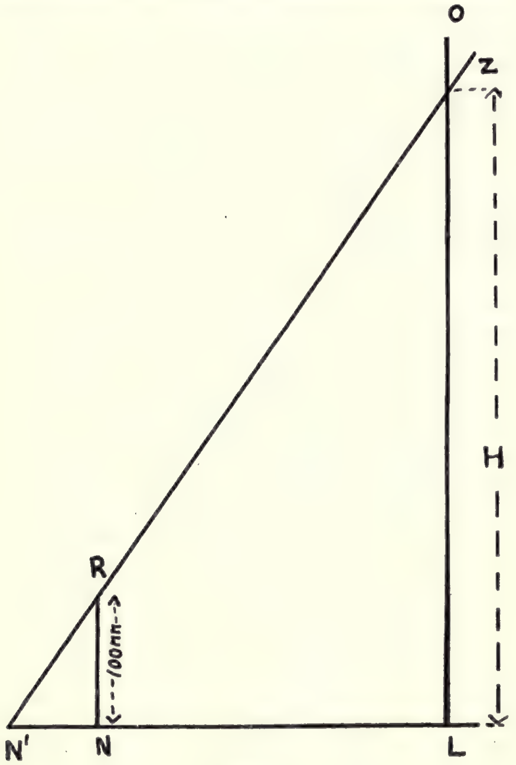


FIG 2.

The negative when developed shows two shadows of the foreign body, D and D¹, two shadows of the height-finding needle, N, and two shadows of each of the cylinders, T and T¹.

There will be a very dark shadow where the two shadows of each cylinder cross. Pencil lines are now drawn (either on the negative or on a print) down the well-defined edges of these dark shadows, and the points where these lines intersect L and L¹, see Fig. 1, indicate the exact position over which the tube stood when each exposure was made, and the distance, L to L¹, indicates the distance the tube was moved.

Lines are now drawn from L to the shadow of the bullet D¹, and from L¹ to its other shadow D; the intersection of these lines indicate the exact position of the bullet relative to the ink mark of the wire triangle on the patient's skin (it does not matter whether the shadow of the foreign body thus revealed falls inside or outside of the triangle). I must mention here that the use of metal cylinders for finding points L and L¹, and point X, was described by Burrell some years ago.

The only measurement now required is the height of the X-ray tube from the plate, and this can be found from the shadow of the height-finding needle by simple proportion.

As the length of the shadow of the height-finding needle, N¹ N, *is to* the actual length of the needle (10 cm.), *so is* N¹ N, plus the distance of L from N to the height of the tube.

Example.

$$\begin{array}{llllll} N^1\,N & : 100 \text{ millimetres} & :: & N^1\,N + N\,L & : H \\ 50 & : 100 \quad ,, & :: & 50 \;+\; 150 & : H \\ \textit{i.e.}\ 1 & : \;2 & \text{as} & 200 & : H \\ & \therefore H = & 400 & & \end{array}$$

The depth of the bullet X is now found from the following formula:—

$$X = \frac{DH}{D+L} \text{ where}$$

X = The depth of bullet.
D = Distance D to D¹.
H = Height of the tube.
L = Distance L to L¹.

To save the trouble of making these calculations to find the height of tube and the depth of bullet, the results can be arrived at graphically as in Figs. 2 and 3.

Fig. 2 shows the graphic method of finding the height of the tube. The two measure-

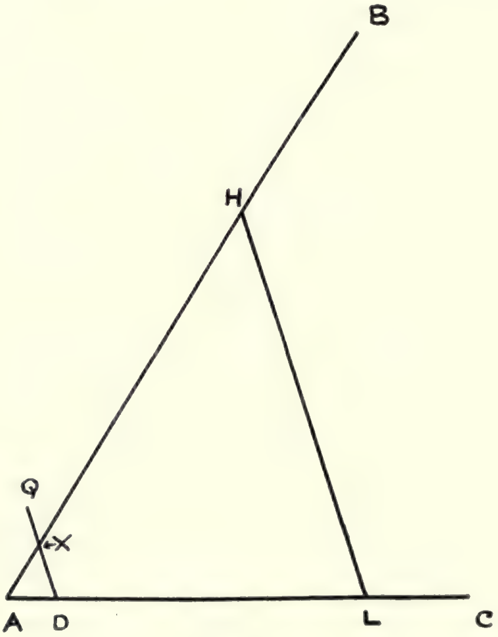


FIG. 3.

ments, N^1 N and N L, are set off on a horizontal line, and a line N R is now drawn at right angles to this line from point N equal to the height of the height-finding needle, (10 centimetres) and another line L is drawn from point L also at right angles to the horizontal line.

The height of the X-ray tube, H, is now indicated by the intersection of line N^1 Z and line L O.

Fig. 3 represents the graphic method of finding the depth of the bullet.

Two lines, A B and A C, are drawn at any angle to each other, a distance, A D, is marked equal to the distance D to D^1 in the photo, and a distance, D L, is marked equal to the distance L to L^1. The height of the tube H is now marked off on the line A B, and a line drawn from H to L.

A line, D Q, is now drawn from D parallel to L H, which intersects the line A B at X, A X equals the depth of the bullet from the surface of the plate.

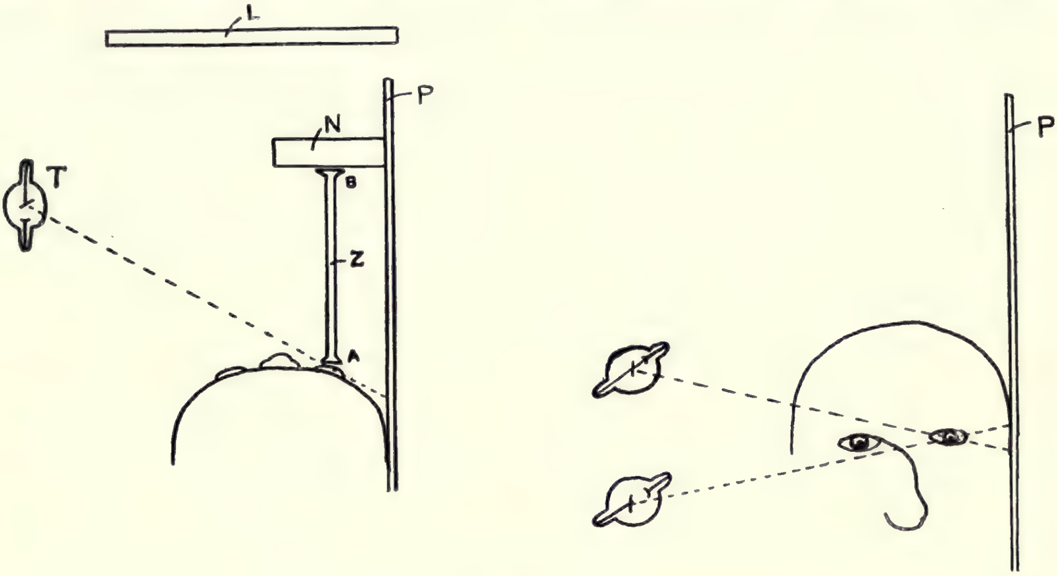


FIG. 4.

Where several pieces of bullet or other foreign body are present they can all be located by this method from the one negative.

In order to give the surgeon in charge of the case every possible assistance in marking the exact spot on the patient's skin below which the foreign body will be found (especially from photographs in which the foreign body is shown outside the triangle), I employ a very small triangle, the sides of which measure only 2·5 cm., in order that the whole of the triangle may be marked on the patient.

When the surgeon receives the negatives or prints he also receives a small sheet of stiff transparent celluloid, on which is a tracing, taken from the photograph, showing the triangle and also the exact position, X, of the foreign body. The surgeon has then only to hold this against the patient so that the triangle fits exactly over that marked on the skin, and mark the point X by pricking a small hole through the celluloid. Should the patient not be in the same position as when the plate was taken, the triangle on his skin will be distorted by movement of his muscles. To get the limb in the right position it must be moved till the two triangles fit. Stiff celluloid is used so that when it is held against the patient it remains flat, and does not bend round and distort measurements. It must be remembered that the surface of the celluloid represents the surface of the X-ray plate, and it is from this surface that all the depths are measured.

When several foreign bodies are present only one plate is necessary, as each foreign body can be located from its two shadows and its exact position relatively to the triangle found by lines drawn from L to L^1.

I have also worked out the following method of locating foreign bodies in the eye; but this method is applicable to any case in which it is required to measure the depth of any foreign body from two positions at right angles to each other, see Fig. 6 (lateral and antero-posterior measurements).

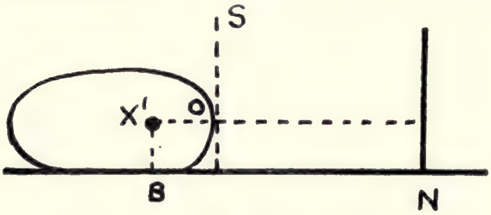


Fig. 6.

Briefly, the method is as shown in Fig. 4. The plate, P, is placed by the side of the patient's head, a looking-glass, L, at right angles to the plate enables the patient to place his head squarely with the plate; to do this he looks with his undamaged eye at that eye in the looking-glass which is directly in front of him, he then turns his head about until the pupil of his eye is central. The inked triangle is now placed between his head and the plate.

The localizer, N, is placed at right angles to the plate, and so that the height-finding needle is at a known distance from the surface of the injured eye. This is easily done by the use of a little standard distance piece, Z, which is made of such a length that when one end of it, A, is placed against the eye, and the localizer at its other end, B, Fig. 4, the needle is 7·5 cm. from the surface of the eye. The tube is then placed at any convenient position, T, so that the rays may miss the skull as much as possible, and two exposures are made by moving the tube up and down, as shown in Fig. 4.

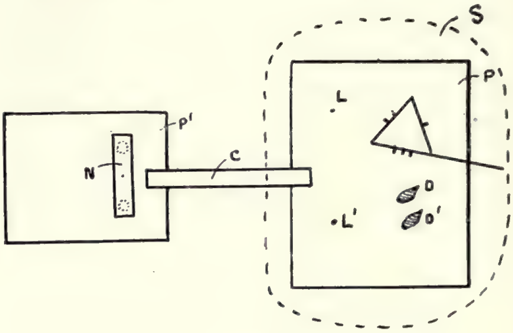
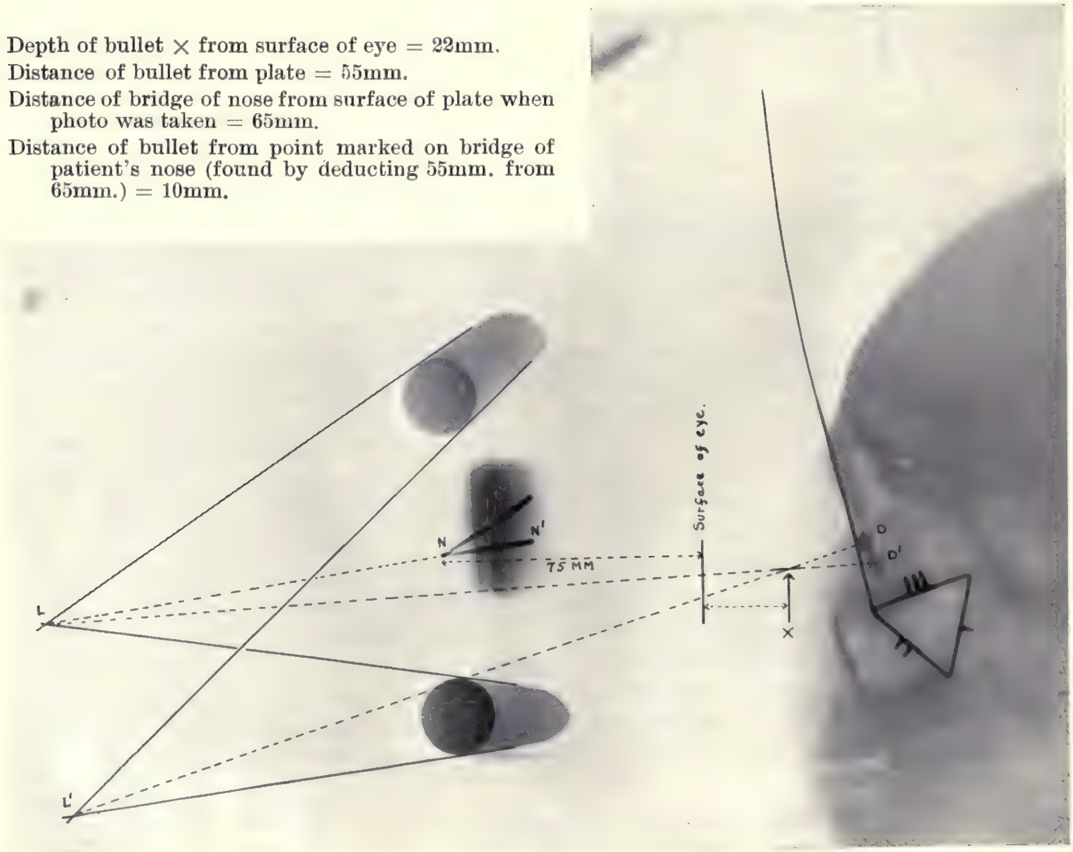


Fig. 7.

The exact position of the foreign body, X, is found as before by drawing lines from L to D^1 and from L^1 to D (Fig. 1). The distance from X to N (Fig. 5) is now measured and the difference between this measurement and 7·5 cm. gives us the depth of the foreign body

Depth of bullet × from surface of eye = 22mm.
Distance of bullet from plate = 55mm.
Distance of bridge of nose from surface of plate when photo was taken = 65mm.
Distance of bullet from point marked on bridge of patient's nose (found by deducting 55mm. from 65mm.) = 10mm.



Patient with air-gun bullet at back of eye.

from the surface of the eye. The distance of the foreign body from the surface of the plate is worked out from the $X = \frac{DH}{D+L}$ formula. The position of the bullet, X, relatively to the triangular mark on the patient's face is found by means of a tracing.

Instead of giving the surgeon the distance of the foreign body from the surface of the plate, a measurement can be given from the centre of the bridge of the patient's nose, as follows.

Having placed the patient's head squarely with the plate, a small mark is made in the centre of the bridge of his nose, and its distance from the surface of the X-ray plate is then measured. The difference between this measurement and the distance of the foreign body from the surface of the plate gives us the distance of the bullet from the mark on the bridge of his nose.

The accompanying photograph is of a boy with an air-gun bullet at the back of his eye, which I took for the Royal Hospital, Richmond, and which has been successfully removed by Dr. Blair.

For the localization of foreign bodies in the thorax or pelvis the same method may be employed, but in order to avoid the use of very large plates, two small ones, P and P^1 (Fig 7), are used.

The larger, P, is placed beneath the patient, S, and records the shadows of the foreign body and the inked triangle, whilst the smaller plate, P^1 (which is placed by the side of the patient), records the shadows of the localizer. A strip of brass or other metal, C, is laid across the space between the two plates, and the shadows of its ends on the plates enables the radiographer to replace the finished plates (or prints) in exactly the same positions in relation to each other as when they were exposed. Measurements can now be taken as if only one large plate had been employed.

Points L and L^1 (Fig. 7) indicate convenient positions for the two exposures.

CLARK'S PATENT FLUORESCENT SCREEN LOCALISER, Oct. 6th, 1914.

By Thomas Clark, Bishopston, Bristol.

Its special purpose is the rapid and accurate localisation of bullets and other foreign bodies by means of the fluorescent screen; the apparatus is so arranged that it gives complete protection to the operator. The screen is supported some little distance above the patient, and is not brought in contact with the patient so that cleanliness is insured. In keeping the screen a little distance from the body, one gets a greater movement of the

References to Fig. 1.

A. Tube box.
B. Screen.
C. Wood frame with cross wire and indicators.
D. Table top.
E. Arrangement for raising and lowering the screen, fitted with opaque panels to protect the operator.
F. Fluoroscope.

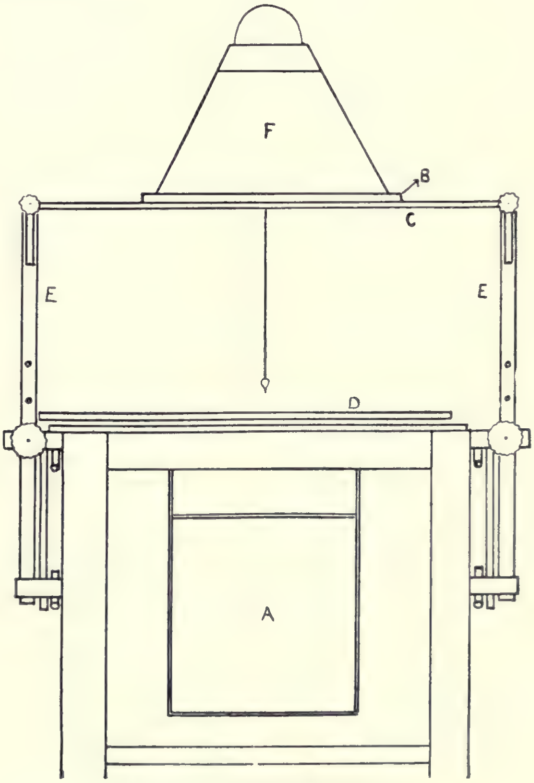


Fig. 1. Horizontal Table.

shadow upon the screen, and thus a more accurate measurement of the movement of the shadow, and this movement is registered, while the screen is still illuminated, by a special metallic lever indicator—see fig. 3.

The tube is centred for the vertical ray by means of two sets of cross wires, one on the top of the tube box and the other just below the screen. Before centering the tube the two sets of cross wires are tested by means of a plumb line. The tube may then be tested by means of the screen, placed upon the upper frame (fig. 3) and fixed within its box.

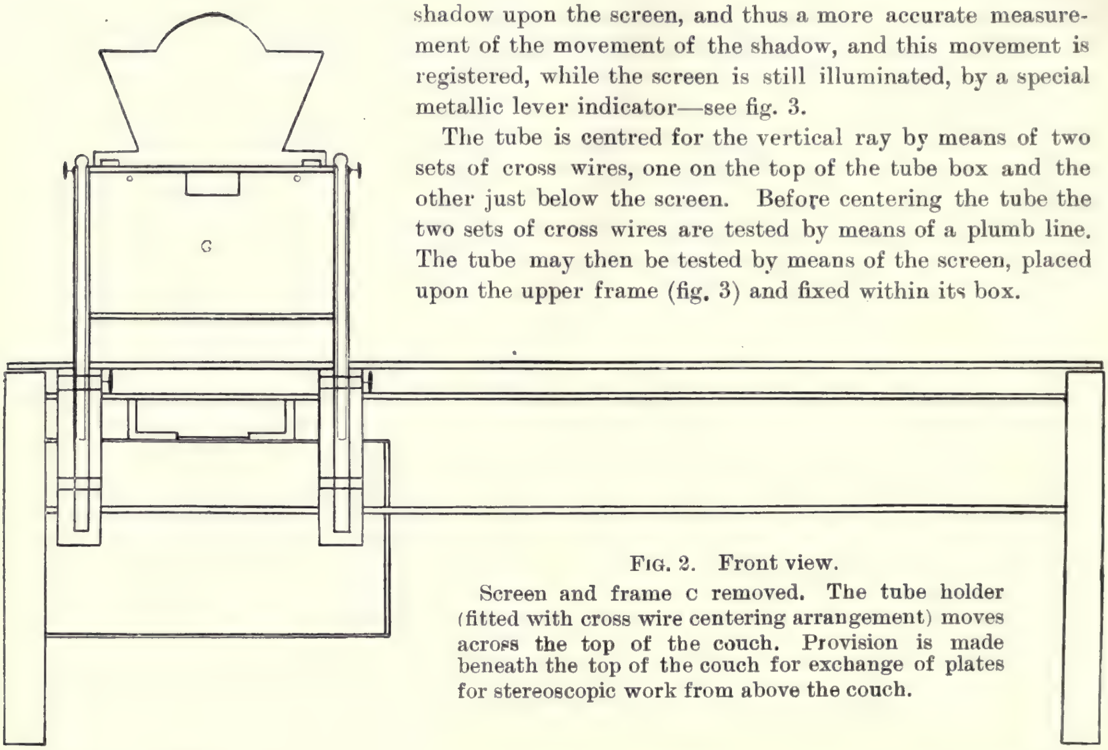


FIG. 2. Front view.
Screen and frame C removed. The tube holder (fitted with cross wire centering arrangement) moves across the top of the couch. Provision is made beneath the top of the couch for exchange of plates for stereoscopic work from above the couch.

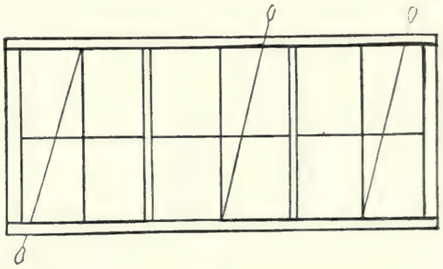


FIG. 3.
Frame with three sets of cross wires, and metallic indicators projecting beyond the frame.

The localising arrangements and tube box move together the length of the couch, fitted upon a frame carrier with ball bearings. A special device is fitted to allow the marking of the body on its lower surface. The top of the couch is made in the form of a

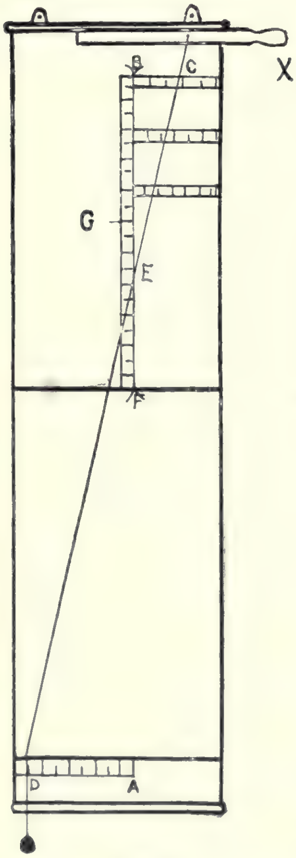


Fig. 4.

FIG. 4.—Indicator. This consists of one vertical and four horizontal rules. The distances from A to B and A to D are known. The movement of the shadow is indicated by the movement of the cross thread at C. The cross thread with weight intersects the line B, which represents the vertical ray from A. E gives the depth of the bullet from B, which represents the upper cross wires. B to C is the distance of the skin of the patient from the upper cross wire.

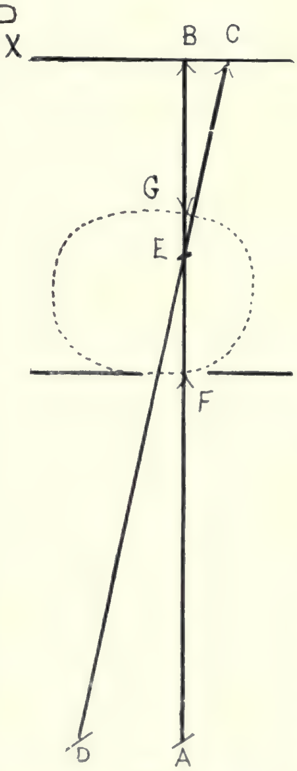


Fig. 5.

Fig. 5.—The diagram showing essential points. A D.—The movement of the tube. B C.—Movement of the shadow. G F.—Marks placed upon the limb. E.—Depth of the bullet.

stretcher—one half wood ply, the other half in movable sections. Provision is made for the top of the couch to move on roller bearings to facilitate adjustment. The stretcher top may be carried to the bedside or direct to the operating theatre, allowing the patient to remain in exactly the same position at the time of operation which he occupied when the screen examination was made.

The practical details of the method :—

1. To mark the body front and back with iodine to indicate where the vertical rays enter and leave the body. (The slightest degree of rotation of limb will be shown by the two marks.) Into this path the bullet can be easily brought, as shown upon the fluorescent screen, at the intersection of the cross wires.

2. To obtain the depth of the bullet the tube is moved across the body four inches, and the shadow of the bullet then falls into a different position upon the screen. Provision is made to indicate this second position, and the amount of movement of the shadow can be measured after the screen is removed and the light turned up.

3. The position of the upper cross wires can be marked on the upper aspect of the body by means of a plumb bob suspended from the cross wire, as well as the lower aspect of the body from below the top of the couch.

The results can be plotted out on the indicator (fig. 4) in a few seconds, showing the depth of the foreign body below the mark on the upper aspect of the body.

CORRESPONDENCE.

ON THE APPLICATION OF MODERN LOCALIZING METHODS TO NON-MILITARY RADIOGRAPHY.

To the Editors of the ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY.

DEAR SIRS,—The reproduction in your May issue of Dr. Oram's paper on gall-stones, in which he discusses the differential X-ray diagnosis, leads me to bring before your readers some of the uses of exact localization in general surgery.

Gall-stones and urinary calculi, separated pieces of bone and loose bodies in joints are now being dealt with at the Cambridge Hospital on the same principles as metallic fragments. That is to say, the vertical line on which they lie (the patient being either supine or prone), is determined by screen examination, and the skin marked above and below. The exact point on this line at which the stone or other body lies is then determined by direct vision or by the aid of a wall-diagram. With a plate on the anterior surface of the abdomen, and a " double image," it is possible to show that a shadow, believed to be that of a gall-stone, is either near or remote from the front of the body: the information is definite in inches or cms., and does not depend on personal judgment, as in the case of the interpretation of stereoscopic appearances.

Calculus shadows are sometimes difficult to pick up on the screen, but by " cutting down " on the area where, from the plate, they are known to be, and by careful attention to detail in the working of the apparatus, success can usually be obtained. Sometimes an examination of the illuminated area by a large magnifying glass is of assistance.

In the few instances where the shadow cannot be seen, the depth from the surface may still be determined approximately. The tube is centred beneath that portion of the body where the stone appears to lie, and a " double image " taken as before. Of course, one cannot be sure that the anticathode has been quite vertically below the object, but the final error in the calculated depth will not exceed a few millimetres, and therefore the value of the procedure as an aid to differential diagnosis between gall-bladder and kidney stone is hardly affected.

I may add that in making skin marks, two long lines should be drawn at right angles through the original dot, their ends being well away from any possibility of disturbance by the operation. In this way the position of the original dot can always be found, even after much "sagging" of the wound.

Yours, etc.,

F. HERNAMAN-JOHNSON.

Cambridge Hospital,
Aldershot.
May 18*th*, 1915,

Pretoria Hospital,
Box 201.
12/5/15.

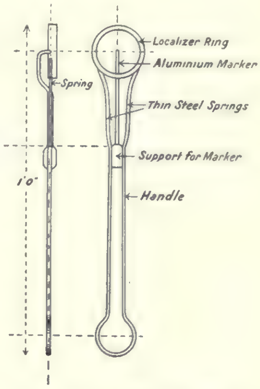
To the Editors of the ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY.

DEAR SIRS,—On page 144 of Addyman's "Practical X-ray Work," 1901, you will find a full description of a localizing instrument called a "Prevetograph." This you will notice is the Ring Localizer of Dr. Hernaman-Johnson under another name.

I constructed a pair of these instruments in 1910 and found them exceedingly useful and accurate.

In place of Mr. Addyman's marking device, I employed the simple arrangement shown in the sketch.

In this the ring is supported by a pair of flexible flat springs. Into the centre of the ring projects an aluminium rod bent at right angles, so that the sharp pointed tip occupies a position slightly behind the plane of the front of the ring. Thus, when the localizer is placed on the body a slight pressure on the handle causes the point to move forward, and if a little aniline blue be placed on the point beforehand, a mark is made on the skin exactly in the centre of the ring. Two localizers are used and marks made simultaneously on both sides of the limb.



Ring Localizer with marker.

These localizers being in one piece, and entirely of metal, are cheap to make, and very easy to sterilize.

Yours faithfully,

G. E. ENSOR.

NOTICES.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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ON THE RADIOLOGICAL TYPES OF PULMONARY TUBERCULOSIS.

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Introduction.

In this preliminary communication a provisional attempt is made to classify more definitely the various types of pulmonary phthisis as seen by means of radiography. It is necessarily tentative, since the burden of proof depends upon the pathological anatomy, and this is seldom available in the earlier and more important stages. Moreover, when the conditions have become chronic, all the structures within the lungs, and the pleura itself may be affected, a summation of shadows almost impossible to differentiate being produced.

As described in the recognised medical text-books the divisions of the disease are not satisfactory, inasmuch as they depend either upon such circumstances as the nature of the course and severity of the symptoms and signs (acute, subacute, chronic), or upon quantitative considerations alone. In other words these clinical classifications do not refer, except in a very general manner, to the particular anatomical structures involved.

Radiographical types.—These may be arranged under the following heads:—

I. *Tuberculosis of Bronchial Glands.*—(*a*) Tracheo-bronchial, (*b*) bifurcation, (*c*) hilum, (*d*) pulmonary (isolated or solitary).

II. *Peribronchial Phthisis.*—(Peribronchitis tuberculosa) with its subdivisions, (*a*) simplex, (*b*) exsudativa, (*c*) disseminata, (*d*) fibrosa.

III. *Bronchopneumonic Phthisis.*—(Lobular.)

IV. *Pneumonic Phthisis.*—(Lobar.)

V. *Pleuritic Phthisis.*—(P. tuberculosa.)

VI. *Apical Phthisis.*

VII. *Miliary Phthisis.*—(*a*) Subacute, (*b*) acute,

I. Tuberculosis of Bronchial Glands.

Inflamed, caseous and calcified glands produce increased opacities. A fine shadow outside the sternum in the neighbourhood of the vertebral ends of the 3rd, 4th and 5th ribs is produced by swollen tracheo-bronchial glands. A dim area at or just below the level of the vertebral end of the 6th right rib, joining that of the hilum, denotes enlargement of the bifurcation glands. In a good plate these glands may also be seen through the median cardiac shadow. The normal hilum opacity lies at the level of the vertebral ends of the 5th, 6th and 7th ribs. When affected, it becomes abnormally dark, broad, and contains a number of circumscribed shadows. In this type there is usually some peribronchial striation and deposition within the pulmonary fields. The bacilli travelling centripetally from the bronchioles and alveoli along the lymphatics generally leave evidences on the way. But there are instances where the lung is clear and devoid of nebulæ and striæ. One obtains the impression that in some cases these central gland opacities are not aerogenous, but lymphogenous, since they may be accompanied by the presence of enlarged glands within the axillæ, the anterior and posterior triangles of the neck and the anterior mediastinum. With regard to the isolated foci found in adults within the pulmonary fields, and the apices, these are often entirely unconnected with the hilum. They may represent the residues of an early peribronchitis tuberculosa, or of a localised aerogenous infection. In the adult such remainders may become reactivated, enlarge, caseate, and break nito a bronchus giving rise to a sputum containing numerous bacilli.

II. Peribronchial Phthisis.

In this division the lymphatic ducts as well as the glands are implicated ; the adjacent walls of the bronchi, alveoli and blood vessels becoming involved, with the production of tuberculous nodules. It is to be regarded as the framework or prototype on which most of the remaining divisions are constructed. For the sake of convenience it may be subdivided into four subordinate types.

(*a*) *P. Tuberculosa simplex.*—The progress of the disease is slow and the processes of repair or reaction on the part of the individual are well maintained. The tubercles unite to form small seed-like bodies of variable size, with a tendency to fibrosis or encapsulation by connective tissue. These are seen within the subclavicular triangles, the apices, between the spine of the scapula and the vertebræ (apex of lower lobe), about the angle of the scapula, and along the bronchi leading to the diaphragm. The strands running towards the apices of both lobes and diaphragm become thicker and more opaque than normal. Amongst these three may appear prominent—one passing towards the sterno-clavicular joint, and one towards the axilla. The third reaches the apex of the lower lobe. Many cases are incipient and difficult of diagnosis. There may be few clinical signs or none. Bacilli may be occasionally detected in the sputum after catarrh, influenza, and overstrain. Some, without doubt, are practically obsolete, the reparative processes having retained the upper hand. Nevertheless, they may be liable to periodical relapses when a small focus, which has caseated, may become active and irrupt into a bronchus giving rise to a bacillary sputum. A differential blood count will reveal a smaller percentage of polymorphs and an increase in the number of large mononuclears and lymphocytes.

(*b*) *P. Tuberculosa exsudativa.*—In these cases the bacillary processes (inflammation, exsudation and caseation) are predominant: the resistance of the organism is feeble, and the production of fibrous tissue is deficient. The nodules increase in size, become cloudy in appearance, and irregularly rounded in outline. Each may enlarge to the size of a cherry, even larger, and still remain discrete. Exsudative nodules may be scattered over the pulmonary fields or may occur more or less isolated about the spine and angle of the scapula. There is a great inclination to the formation of perialveolar foci, which by fusion produce patches of lobular, and tracts of caseous pneumonia (consolidation) with cavitation. Both in children and young adults the course of the disease may become rapidly acute.

(*c*) *P. Tuberculosa disseminata.*—In these cases there is an extensive distribution of small peribronchial tubercles, as if there had been a sudden centrifugal dispersal of bacilli from deeper parts. Some of the areas may contain very small maculæ and may possibly be of the nature of a *partial* or *local miliary* dissemination, due to the irruption of a small caseating focus into a deeply-situated artery. Since the disease may be advancing more rapidly posteriorly, the latter may exhibit large irregular areas, whilst the dorso-ventral plate still shows fields filled with small compact foci. Mixed forms may occur: patches of exsudative, alternating with others of the disseminative type. The former will generally become confluent before the attainment of any marked degree of dissemination.

In spite of the wide distribution the process may become chronic, and the internodular regions less translucent owing to the growth of fibrous tissue; the foci may be converted into small fibroid nodules or into small caseating centres, leading in the latter to the production of small cavities, the surrounding tissues finally becoming densely fibrosed. On the other hand, as in the previous form, the nodules may multiply and eventually unite forming uniform consolidated bronchopneumonic and pneumonic shadows, which caseate and produce larger cavities with thickened walls, either within the apices or subclavicular triangles. The perialveolar or submiliary deposition, with the associated capillary congestion, may explain the repeated slight attacks of hæmoptysis in cases without sputum, with little or no cough, and a paucity of physical signs; or the hæmoptysis may arise from an infiltration of the hilum into the adjacent tissue of the lung, which being deep and central is inaccessible to the stethoscope.

(*d*) *P. Tuberculosa fibrosa.*—(Chronic indurative or fibroid phthisis) is the usual termination of fairly extensive peribronchitis tuberculosa in individuals with good reactive powers. Proliferation of connective tissue is exuberant, and spreads to the interstitial and interlobular connective tissue, producing increased opacities and irregular, often honeycomb-shaped, outlines corresponding to the superficial lobular divisions. Areas of diffuse cloudiness, attended with striation and containing small dense shadows, are seen, particularly in the upper lobes. The apex is generally obscure, but may show denser areas of fibrosed or calcareous foci. Thickened apical linear shadows may be calcareous plates. The latter may occur in any part of the pleura. The apex shrinks, its alveoli become obliterated, and a compact pleural cap often augments the dimness. Localised caseation, cavitation and calcification often occur within the pulmonary fields. The heart and trachea may be displaced towards the diseased side. There may be sinking of the ribs (roof-tiling) of one side, and an emphysematous condition of the other. The pronounced emphysematous form of pulmonary tuberculosis—a modification of this type—often exhibiting signs of obsolete hilum-phthisis, and probably originating during childhood, will be described in a later communication.

Cylindrical dilatation of the bronchi (bronchiectasis) may occur in any of the chronic forms. It is to be found chiefly in the lower lobes, between the hilum and the diaphragm. On the radiogram the bronchi may be divided transversely, obliquely, or longitudinally. The former show a double contour (owing to thickened walls) with a central air space; and they are surrounded by heavy opacities due to an excess of connective tissue. When cut longitudinally they may appear to run with little diminution of calibre as far as the diaphragm. We shall enter more fully later into the question of small ampullary dilatations.

III AND IV. BRONCHOPNEUMONIC AND PNEUMONIC PHTHISIS.

These types may be combined since the latter is merely an extension of the former. The exsudative and disseminated forms of tuberculous peribronchitis, especially the former, readily lead to the formation of small or large consolidations in the vicinity of the hilum alone or within any of the lobes of the lung. Interlobular and interlobar thickenings of the pleura may be present, although the extension of the pneumonic consolidation as a rule pays little regard to the anatomical limits of the lobes. Cavitation usually follows.

V. PLEURITIC PHTHISIS.

There are some instances, apparently, of almost pure pleuritic involvement, where the invasion has spread, either to the surface of the lung from a superficial peribronchial focus, or along the surface of the pleura from tuberculous tracheobronchial and bifurcation glands. On account of its density, when extensively developed, the condition of the deeper parts of the lung may be concealed. It is perhaps commoner on the left side; it possesses a marked tendency to fibrosis, and contraction of the lung, with roof-tiling of the ribs, diminution of respiratory capacity, high fixation of the dome of the diaphragm (pleuritic form of fibroid phthisis), and occasional unilateral hypertrophy of recti and obliqui. It may sometimes follow pleurisy with a serous effusion or an empyema.

In many cases of peribronchial phthisis in children pleurisy is a frequent associate. It may be ultraclinical and only discernible on the screen as a thin almost translucent investment. From pathology we learn that it is commonest over the anterior edges of the upper lobes, over the diaphragm, the hilum and mediastinum, that is the more central situations.

VI. APICAL PHTHISIS.

This type may be placed in a separate section in accordance with the opinions of many clinical authorities. The method of invasion may be primary (rare) or secondary. The radiographic results may be summarised thus :—

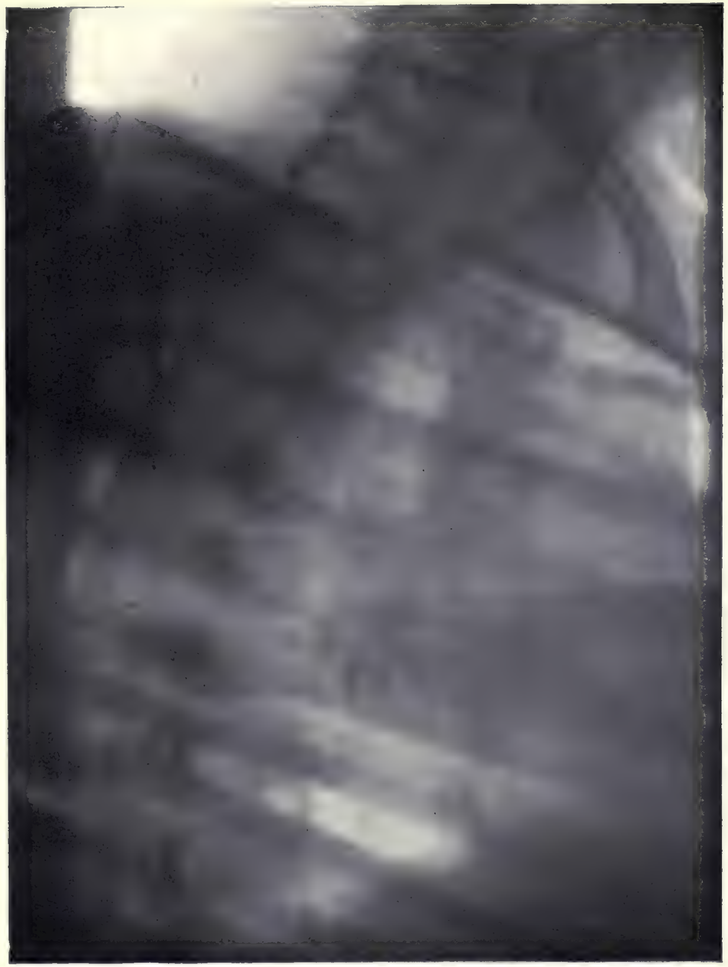
(1) *Peribronchial type*, deposition and scattering of nodules which may conform to one or more of the four subdivisions already mentioned—(*a*) simplex, a few scattered tubercles, (*b*) exsudativa, (*c*) disseminata, and (*d*) fibrosa. In the last the apical field is covered with fibrosed threads or it may present a striated restiform appearance. (2) *Apical bronchopneumonic*, with a general or localised uniformity of shadow and a great tendency to cavitation. (3) *Apical miliary*, which may be accompanied by a general miliary phthisis, or may arise from the peribronchial disseminated form. These three varieties are liable to be obscured by the presence of (4) *apical pleurisy*, which leads to the formation of a dense pleural cap, to linear shadows which may be calcareous plates, or to atelectasis.

As a general rule, marked changes in the apex are attended by an increase in the extent and density of the hilum, and by the visual evidence of intimate lines of communication between the two, the latter being often beset with peribronchial nodules. Occasionally the association is wanting. This defect must be due either to a primary ærogenous deposition within the apex, to an imperceptible transference or metastasis of the bacilli from deeper sources, or to a retrogression and obliteration of the connecting links themselves.

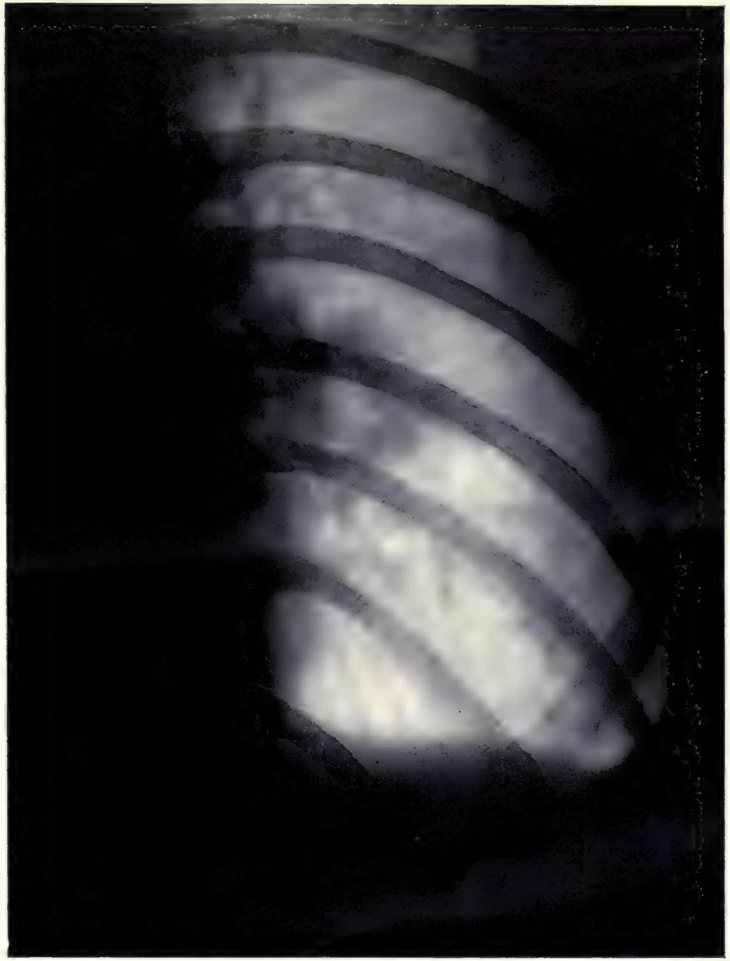
VII. Miliary Tuberculosis

May be at first peribronchial and perivascular, when it is a mere *local* or *partial* dispersal produced by the irruption of bacilli into a deep-seated artery, or the bacilli may come from extra pulmonary situations, as in tuberculous meningitis, when the dissemination becomes general. Of the latter two varieties are distinguishable, (*a*) *the subacute*, where the foci form circular opacities rather above pinhead size, surrounded by clear areas with no attempt at fibrous transformation ; (*b*) *the acute*, in which the maculæ are minute, even less than poppy seeds, and the plate is almost uniformly dull on account of the immense number of foci and the accompanying œdema.

The types most liable to render the clinical diagnosis dubious are (1) the purely glandular type ; (2) the simplex type and disseminated type of peribronchitis, (3) the pleuritic, and (4) the hilum-infiltrating (central phthisis). References to authorities will be given in the complete communication.

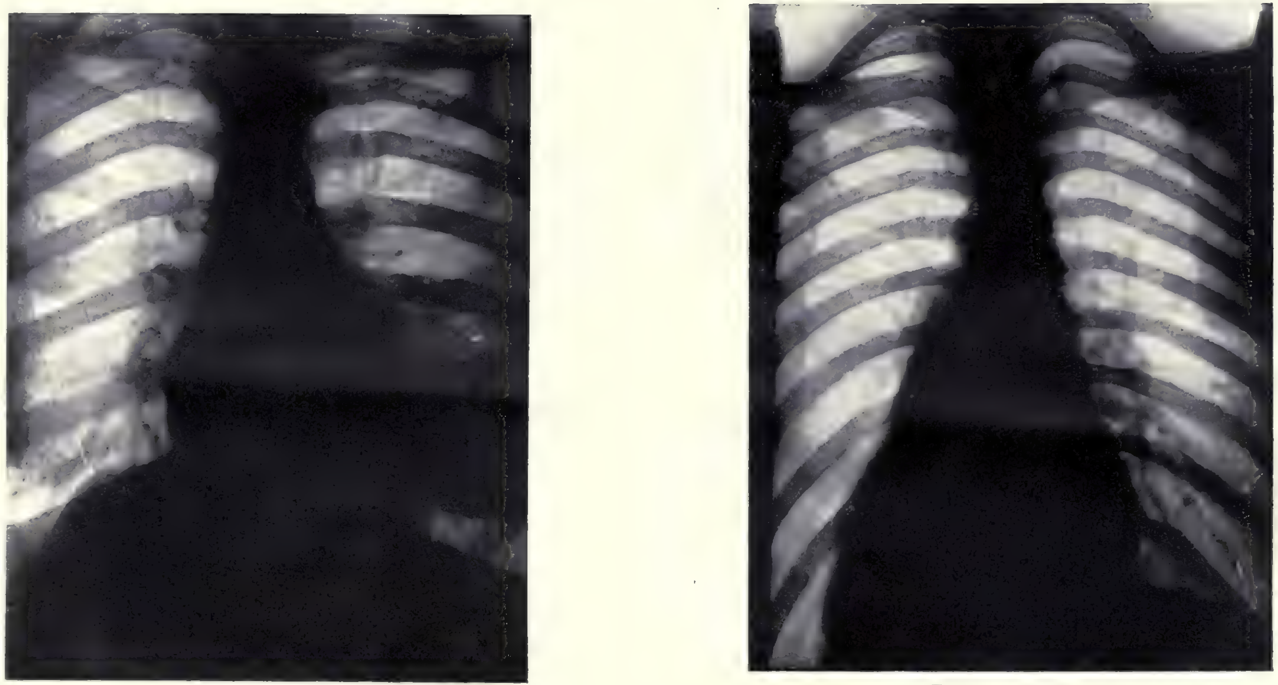


Radiogram No. 1.—*Tuberculosis of mediastinal glands* in a child. Left oblique position, showing the posterior mediastinum and the posterior portion of the superior mediastinum, with the cardiac and aortic opacities in front, and the vertebral column behind. Between them is a mass, consisting of enlarged mediastinal glands and containing several calcareous foci.



Radiogram No. 2.—*Caseating pulmonary focus* which has perforated the right bronchus at the level, between the vertebral ends of the eighth and ninth ribs.

Plate 13.

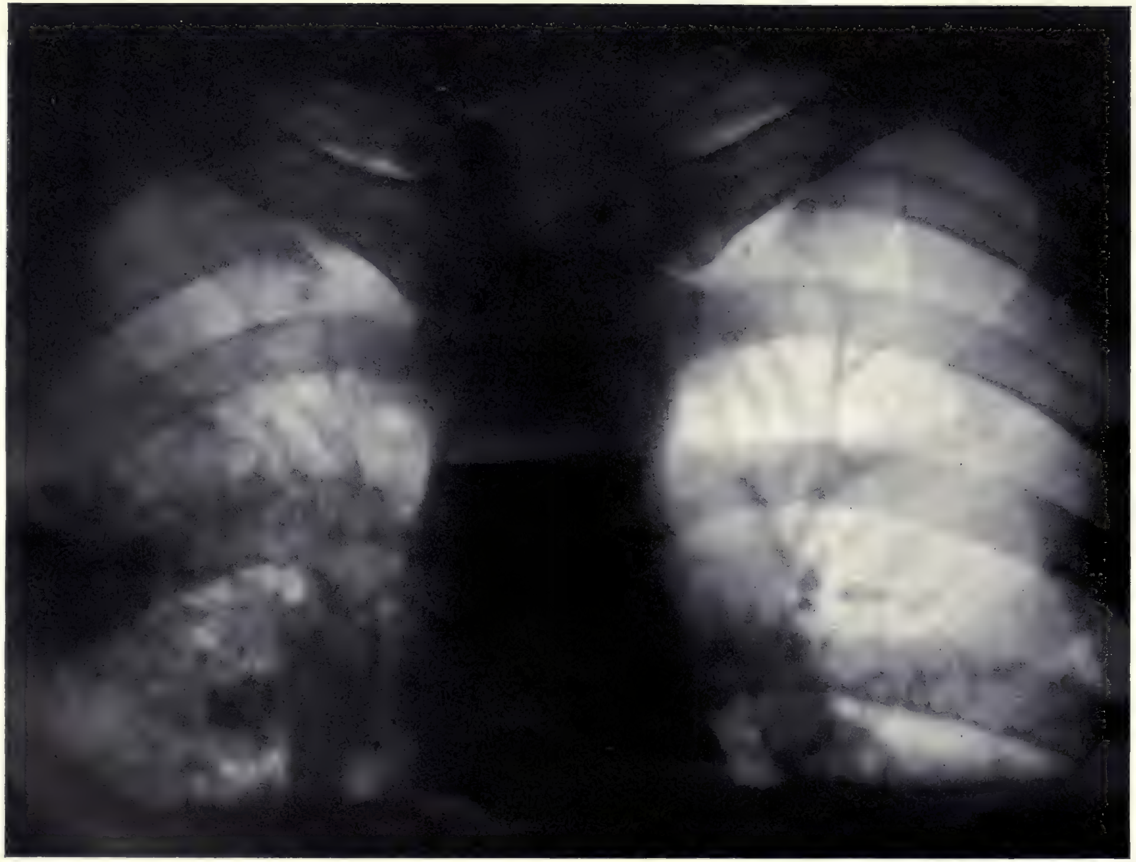


RADIOGRAM 3A.

RADIOGRAM 3B.

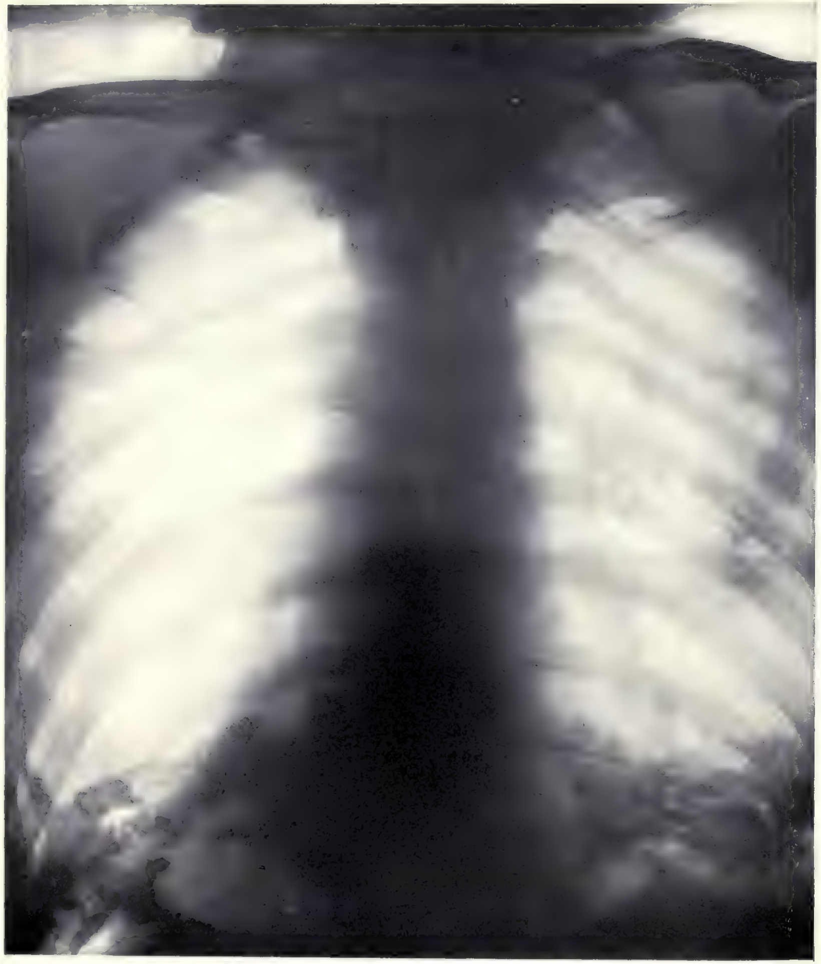
RADIOGRAM NO. 3.—*Peribronchitis tuberculosa simplex.* Small foci scattered throughout the right lung; fibrotic and dilated bronchi at the right base. 3A. Dorso-ventral. 3B. Ventro-dorsal.

PLATE 14.

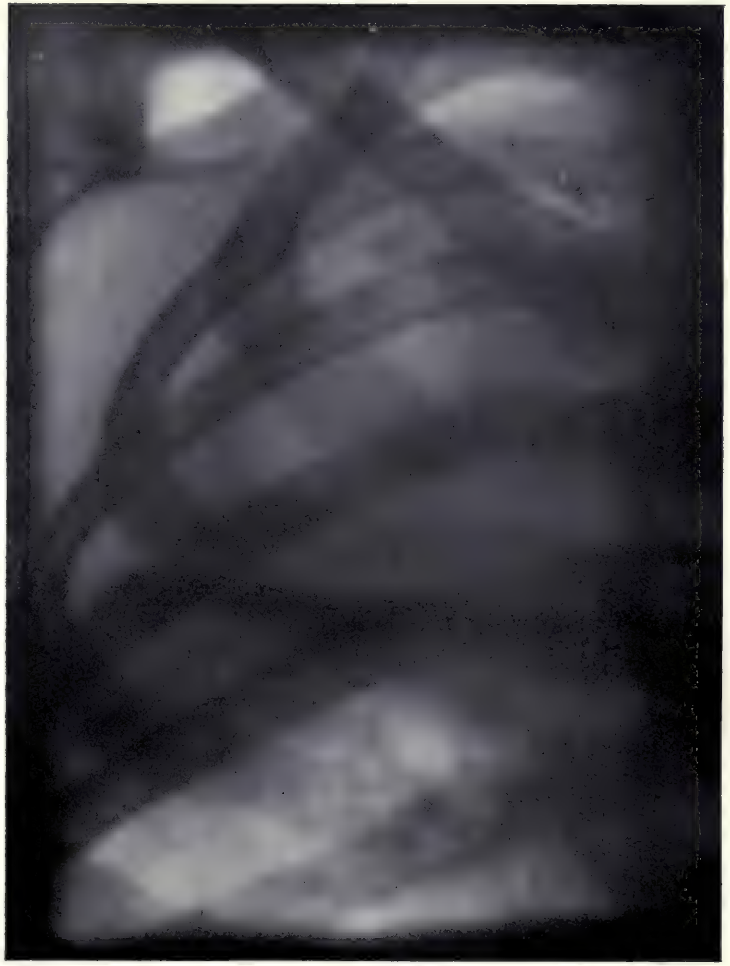


Radiogram No. 4.—*Peribronchitis tuber. disseminata* in both lungs. In addition on the right side some bronchopneumonic consolidation, at the level of the anterior osseous extremity of the third rib.

Plate 15.

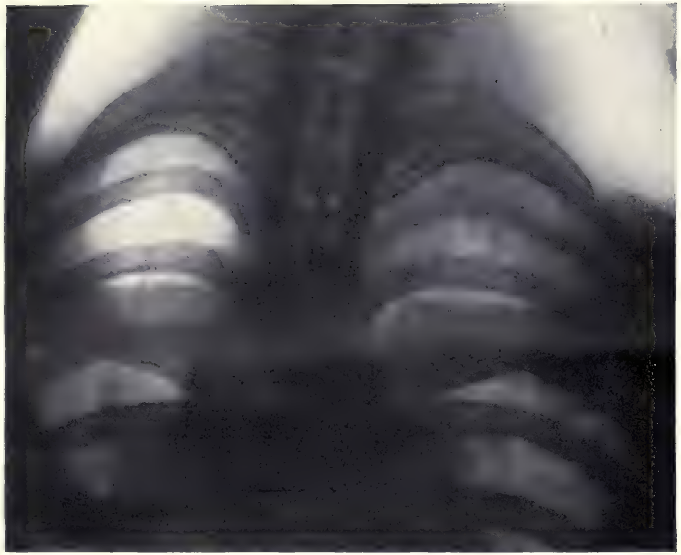


Radiogram No. 5.—*Peribronchitis tuber. fibrosa.* The right lung, on the plate, showed marked fibrotic induration spreading from the hilum downwards. This is scarcely distinguishable. The plate was lightly printed in order to bring the calcareous plates, at the lower part of pleura of both sides, into prominence.

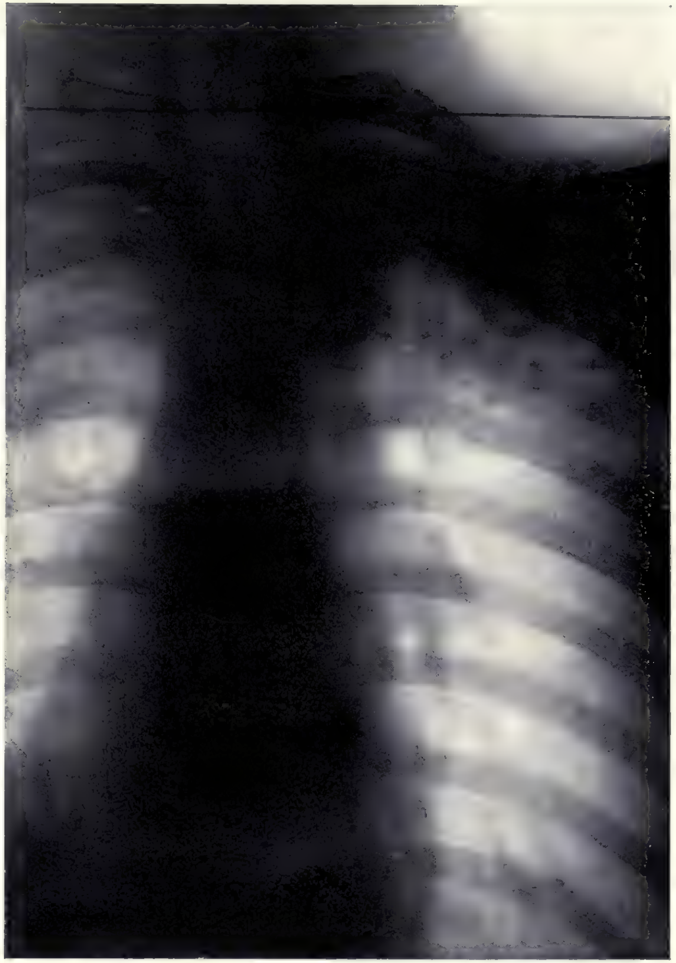


Radiogram No. 6.—*Pneumonic phthisis* in a child, æt. 13, with exsudative peribronchitic foci below; massive pneumonic consolidation above, with a cavity just beneath the clavicle. The lower margin is the advancing zone of the disease.

Plate 16.



Radiogram No. 7.—*Apical disseminated tuberculosis* in a man, æt. 22. Had one attack of hæmoptysis at school, and a second at Sandhurst. On leaving, the physician found signs at one apex: but there was no temperature; no cough; opsonic index was normal; complement-fixation normal. Tuberculin not used. The radiogram shows numerous foci scattered throughout the left upper lobe, principally old and fibrotic; at the left apex some pleuritic opacity; on the right side a pleural cap (indistinguishable in print).



Radiogram No. 8.—*Pure apical tuberculosis.* At the level of the third right rib a caseous mass the size of a shilling with central cavitation. Running from fifth rib on the left side towards the hilum is a linear opacity (fibrosed bronchus).

Plate 17.

ESSAI SUR LES PRINCIPES DE LOCALISATION DES PROJECTILES.

Par le Docteur Foveau de Courmelles.

La détermination de la position des corps étrangers dans l'organisme a fait l'objet de nombreux travaux; leurs principaux directeurs sont constants: l'entrecroisement de deux droites connues, faciles à construire, à repérer, voire à reproduire, qu'il s'agisse de la projection sur l'écran ou d'obtenir des radiographies, on cherche toujours au moyen de points extérieurs des lignes dont le point de rencontre détermine la place du corps étranger.

En radiographie de guerre, on s'est surtout occupé des projectiles, balles de fusil, éclats d'obus ou de shrapnels. Mais on peut aussi recourir à ces procédés d'investigation par les rayons X pour déterminer la place d'autres corps étrangers, tels que les séquestres osseux, les esquilles qui entretiennent la suppuration, et ont autant besoin d'être extraits que les projectiles même. J'irai plus loin dans cette voie et estime que la localisation des lésions médicales: tuberculose commençante, déformations rhumatismales de début, sièges de fractures, points pleurétiques avec épanchements, tumeurs stomacales ou intestinales, vues avec mon *repas opaque* (Académie de Médecine de Paris, 23 Mai 1899) tirerait probablement quelque profit de nos méthodes de détermination précise de leur situation.

J'irai plus loin et, au point de vue de l'identité individuelle, je vanterai la fiche radiographique, avec leur siège exact, des tares, ou accidents osseux et dentaires; elle permettrait de reconnaître les personnes par ces signes visibles aux rayons X ou leurs cadavres méconnaissables: ne sont-ils pas tels souvent, en cette horrible guerre, tels qu'ils le furent lors de l'incendie du Bazar de la Charité, le 4 Mai 1897, alors que de suite le professeur d'Arsonval présentait en mon nom cette application des rayons X à l'Académie des Sciences, et comme l'y rappelait le professeur Branly, en Octobre 1911, après la catastrophe de la Liberté.

Si l'on établissait ces fiches individuelles radiologiques avec localisation et précision, que de maladies pourraient même être ainsi prévenues: par exemple la calcanéodynie avec ergot au talon signalée par MM. Reginald Morton et H. S. Souttar (1), et dont j'ai retrouvé en janvier dernier un cas, avec c'en plus, un os wormien, entre le calcanéum et le tarse: l'opération a guéri le sujet. Les os wormiens pourraient être des signes distinctifs de reconnaissance d'hérédité, peut-être; j'en ai trouvé au même endroit du pouce chez deux soeurs.

Nombreux sont les procédés jusqu'ici spécialisés à situer les corps étrangers, venus du dehors ou existant au dedans et dont on se préoccupe moins. Le procédé de Sir James Mackensie Davidson, l'éminent président de la section de radiologie du dernier congrès des sciences médicales (Londres 1913) jouit légitiment de la plus grande faveur en Angleterre, nous nous bornerons à le signaler. Mais que de méthodes, à croire même que leur abondance masque, comme en pharmacopée, leur insuffisance: Nous croyons, au contraire, que chacune répond à des indications, à des besoins déterminés et que toutes sont utiles.

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(1) Archives of the Roentgen Ray: juillet 1914.

En radiographie, on cherche à obtenir les points de repère soit par des index métalliques fixés sur la peau, Morize 1898, soit par des crêtes osseuses, soit par deux radiographies sur deux plaques différentes, ou sur la même plaques. Nous nous permettrons sur ce dernier point de rappeler la présentation à l'Académie des Sciences de Paris, le 12 Avril 1897, par M. Lippmann, de notre ampoule double et décrite en mon cours de la Faculté de Médecine de Paris, à la même époque. Malheureusement, en ce temps reculé, si proche de la découverte des rayons X, les tubes de Crookes étaient petits, exigeaient des poses prolongées, se détérioraient facilement, chaque opérateur s'en tenait à son procédé, aussi les essais cependant si nombreux déjà, restaient sans portée. On les retrouve aujourd'hui dans les diverses méthodes actuelles, modifiées ou non.

Mon ampoule double était comme son nom l'indiquait, bi-anodique bi-cathodique et bi-tubulaire (fig. 1). Elle concentrait sur une surface restreinte les rayons de deux anticathodes.

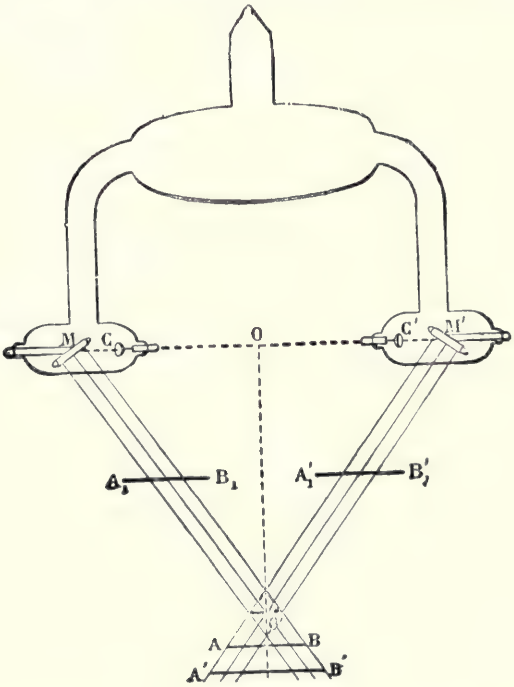

FIG. 1.

Elle constituait, en quelque sorte, deux ampoules réunies en une seule, avec les avantages de deux ampoules distinctes, n'exigeant cependant qu'une seule bobine à longueur d'étincelle, et pour l'ampoule bi-tubulée, un degré de vide, encore difficile à régler ; une ou deux bobines à cette seule ampoule pour obtenir des effets multiples : double image du même objet ou de deux objets, détermination par la triangulation de la situation

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(1) **Foveau de Courmelles. : traité de Radiographie Médicale et Scientifique, cours à la Faculté de Médecine de Paris Préface du Professeur d'Arsonval. Mai 1897.**

du corps éclairé au maximum. Sa forme était —nous avons toujours notre exemplaire de cette époque—celle d'une ampoule ordinaire avec deux tubulures latérales et parallèles; ces tubulures sont terminées chacune par un renflement contenant la cathode et l'anticathode anodique placée en face et inclinée à 45°. Sur une même ligne horizontale axiale sont les centres des deux anodes et les deux cathodes. Les deux cathodes C et C' envoient leurs rayons sur les anodes M et M' qui les réfléchissent dans des directions convergentes. Une modification de cette ampoule consite à intervertir les positions des anodes et des cathodes de façon à avoir en quelque sorte une alternance des surfaces agissantes : cathode, anode, cathode, anode, au lieu des deux cathodes rapproçhées (fig. 2).

Dans ce second cas, les rayons réfléchis par les anticathodes sont peu abondants et frisant la surface réfléchissante, nous y arrivons pour établir, ou mieux, appliquer le principe de l'entrecroisement des images d'un corps étranger pour sa situation. Il ne pouvait s'agir, en l'espéce, vu le peu de rayons sus à cette disposition, que d'un corps de faible épaisseur, à traverser, alors que la fig. 1 est générale, peut fournir les mêmes éléments de triangulation, et deux images égales sur la même plaque ou deux plaques différentes, éléments précieux de stéréoscopie. Nous n'en retiendrons donc que les principes, deux images différentes sur la même plaque, plus faciles à obtenir avec la forme de la fig. 1, une distance connue des anticathodes, une autre distance connue. Celle de leur milieu à la plaque, la distance du corps étranger à ce milieu va en découler et si l'on mesure la distance de ce même milieu à la surface extérieure du blessé en notre hypothèse, on aura la place du corps étranger.

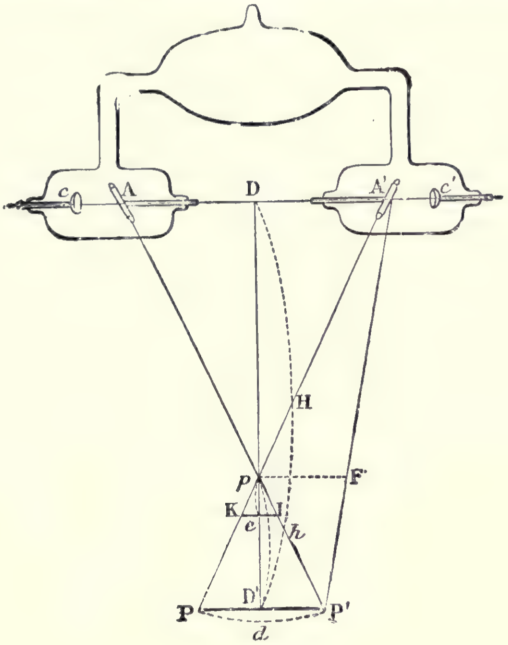

Fig. 2.

On construit sur le papier, avec les dimensions mesurées les triangles semblables A p A′ et P p P′ et l'on trouve :

$$\frac{pD'}{PP'}=\frac{PD}{AA'}$$

et si l'on ajoute numérateurs et dénominateurs :

$$\frac{pD'}{PP'}=\frac{DD'}{AA'+PP'}$$

ou :

$$pD'=PP'\times\frac{DD'}{AA'+PP'}$$

On nous pardonnera d'avoir rappelé ces données de 1897 en regrettant de n'avoir pas vu se vulgariser le principe de l'ampoule double plus facile à construire aujourd'hui et qui pourrait résoudre les problèmes de la localisation et du relief, de rapide façon il y aurait evidement à calculer les distances *optima* des anticathodes convergeant leurs rayons et de celles-ci au corps à radiographier.

Les index metalliques repéreurs employés plus ou moins des le début sont maintenant la base de toutes les méthodes précises en radiographie ou en radioscopie. La réglette avec curseur de Mergier, les anneaux concentriques de Londe, ou son triangle en bois avec espaces métalliques de un centimètre, des cadres métalliques gradués et quadrillés, . . . le tout avec situation et déplacement de l'anticathode parallèlement à l'écran ou à la plaque symétriquement à la normale, distances connues, constituent les méthodes présentes ou passées: les modifications ont varié avec les auteurs, mais ces principes directeurs sont constants. Le stéréoscope et la localisation en découlent.

Barême de calculs selon les dimensions des triangles semblables considérés, report sur des règles graduées avec latéralement, projections sur l'écran ou la plaque et les déplacements symétriques au rayon normal de l'anticathode, donnent immédiatement la distance du projectile à la peau et le point d'incision.

Une mention spéciale doit être faite pour les *compas repéreurs.* Le médecin-major Hirtz a créé son modèle pendant qu'il était à l'hôpital du Dey, à Alger, et son usage, très précis, s'est rapidement vulgarisé, surtout depuis la guerre ; cependant il exige une épure de géométrie descriptive et la situation dans l'espace du corps étranger et de trois points de repère sur la peau choisis arbitrairement. Ces trois points, qui serviront de bases au compas lors de l'opération sont marqués sur la peau au thermo-cautère et portent d'abord trois index métalliques qui s'impriment en double sur les deux radiographies prises sur la même plaque. On détermine le centre du rayon normal, assez proche du corps étranger qu'une opération radiologique préliminaire a presque déterminé ; on prend les deux images par déplacement symétrique de l'anticathode autour du rayon normal, les doubles images au nombre de huit, du corps étranger et des trois points considérés et repérés métalliquement peuvent, projetés sur les plans horizontaux passant par la plaque d'une part, par le corps étranger de l'autre, donner une épure significative. L'établissement de celle-ci exige un certain apprentissage.

Le compas de Hirtz se fixe alors avec ses 5 réglettes mobiles et articulées autour d'un centre sur l'épure pour déterminer, par rapport aux trois points de la peau, la profondeur du projectile. Reportée sur la peau, cette profondeur connue et fixée sur un index, le chirurgien se laisse guider—et si les organes essentiels sur le trajet l'empêchent d'être directement accessible, un arc de cercle surajouté, permet d'atteindre latéralement le corps étranger.

En général, on s'accorde à trouver en France ce procédé radiographique comme le plus précis, et son auteur l'a aussi appliqué récemment à la radioscopie.

En *radioscopie*, on a pu, projetant le corps étranger sur l'écran appliqué sur la peau et deplaçant l'ampoule d'un écart constant et horizontal et la plaçant à une distance connue de l'écran fluorescent, avoir des triangles semblables se reconstruisant automatiquement sur une règle verticale représentant la distance constante de l'ampoule à l'écran ; aux deux extrémités, et perpendiculairement, on porte le déplacement de l'ampoule d'un côté ou de l'autre ; l'écart des deux ombres qui en ont résulté sur l'écran. Un fil tendu aux extrémités de ces deux perpendiculaires croise la règle verticale à l'endroit où se trouve le projectile.

Arrivons maintenant à des méthodes semblables purement radioscopiques et indépendant de la distance de l'anticathode à l'écran, parfois difficile à déterminer. Si ces dernières ont l'avantage de la rapidité, elles ont, certes l'inconvénient considérable d'exposer l'observateur aux rayons X et à leur action nocive. Si les examens sont fréquents, ce qui est le cas à l'heure présente, le danger devient grand. Cependant leur rapidité fera probablement passer sur le danger. Je résume d'abord la méthode de M. Francis Hernaman Johnson prise dans cette revue même (1) en raison même des modifications que nous lui avons fait subir, et qui m'ont permis de l'étendre (Communication à l'Académie des Sciences de Paris, le 19 Janvier 1915).

En diaphragmant le corps étranger et l'encerclant d'un anneau métallique de 3 centimètres de diamètre fixé à une tige de bois, il marque le point correspondant sur la peau et il centre l'anneau au nitrate d'argent ; plaçant ensuite l'anneau en arrière il détermine un autre point marqué de même ; les trois points se trouvent sur la même verticale. Il opère ensuite à angle droit et marque sur la peau deux autres points d'une même verticale perpendiculaire à la première.

Il reporte les points obtenus sur le papier et obtient la figure A, C, B, D, la mesure directe sur le membre A, C, B, donne sur le papier une flèche mesurable C, O indiquant en C le point d'incision ; C, O est la profondeur du projectile. Le point D sert à fixer le chirurgien, son incision faite en C, sur la perpendicularité à suivre.

J'ai opéré d'une façon très analogue, qui rend la méthode générale et plus rapide, tout en supprimant la nécessité de diaphragmer, opération souvent longue pour les corps de petit volume.

J'ai remplacé mon index primitif marquant sur la peau la place du corps étranger, en doublant l'appareil anglais, c'est à dire en prenant deux anneaux fixés sur deux planchettes évidées à cet effet ; le tout est recouvert d'étoffe afin d'éviter au patient la sensation du froid, et par suite ses mouvements intempestifs, pouvant obliger à diaphragmer de nouveau. L'anneau n'est ainsi visible qu'à l'écran. Je regarde le corps étranger avec mon cryptoscope de 1900, boîte d'où se sort où se met l'écran, et qu'un masque appliqué hermétiquement sur le visage de l'observateur placé dans l'obscurité, même en rase campagne, voire permet d'opérer sous le contrôle d'un écran fluorescent.

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(1) ARCHIVES OF THE ROENTGEN RAY, Décembre 1909 et Janvier 1915.

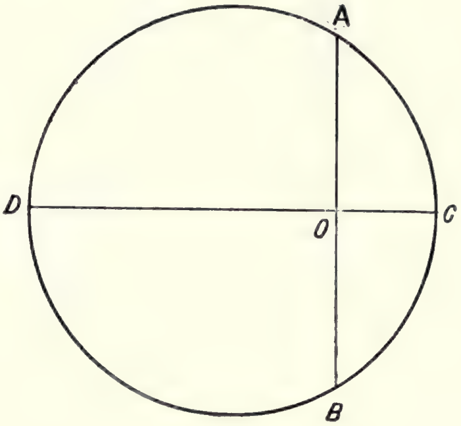

Fig. 3.

Fig. 4.

Le corps étranger, vu, je l'entoure, en avant et en arrière, en même temps, de chacun des anneaux, où un trou au centre laisse entrer, de préférence un déclic avec tampon encreur à l'aniline, ou, à défaut, le crayon de nitrate d'argent ou dermographique, devant marquer les deux points nécessaires sur la peau. J'opère de même, à angle droit, ou non, mais toujours en me plaçant de façon à avoir deux faces parallèles du segment de membre considéré. J'obtiens alors la figure suivante, où le problème de triangulation assez semblable aux résultats précédents de tous ces auteurs ou de mon ampoule double, donne la distance du projectile à la peau.

On a :

$$\frac{EG\ (\text{ou } x)}{GF} = \frac{AB}{CD}$$

ou encore :

$$\frac{EG + GF}{EG} = \frac{AB + CD}{AB}$$

EG + GF est égale à e, l'épaisseur du corps, pris avec un compas d'épaisseur, au milieu des distances AB et CD ; la plus courte de ces distances, soit AB, est la plus rapprochée de corps étranger ; son milieu, ou E, sera le point d'incision, et F, son antipode, un point de repère pour l'opérateur.

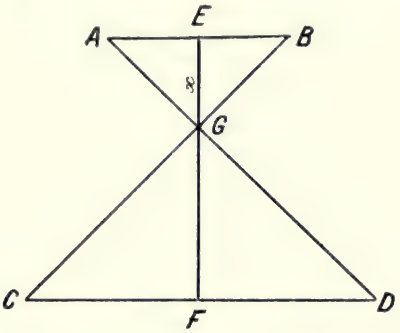

FIG. 5.

On a donc enfin :

$$\frac{e}{x} = \frac{AB + CD}{AB} \quad \text{ou} \quad x = \frac{e \times AB}{AB + CD}$$

e, AB, CD sont connues, x s'en déduit facilement.

Pour le thorax, où, on le comprend, la prise de deux radioscopies perpendiculaires est impossible, vu l'épaisseur dans le sens transversal, à moins de projectiles gros ou de sujets maigres, la même méthode s'applique. On prend le sujet, la face ou le dos opposé à l'écran, mais bien parallèle à cet écran, bien éclairé et qu'on diaphragme ou non, mais l'anneau de devant érant bien concentrique à l'anneau de derrière (je l'ai expérimenté souvent et la vérification en est facile chaque fois), on a la perpendiculaire EF par les deux anneaux encerclant le corps étranger. On place alors de profil le malade, englobant deux segments parallèles, à l'avant et à l'arrière, et l'on a la ligne AD, par exemple, et notre formule de tout à l'heure devient :

$$\text{EG ou } x = \frac{e \times AE}{AE + FD}$$

Le point d'incision est sur la plus petite droite joignant du même côté deux des quatre points déterminés et la distance x est connue.

En cas de segment du corps à faces non parallèles en la perpendiculaire et l'oblique passant par le corps étranger déterminent le point de l'incision et sa direction.

Des constructions géométriques en carton, en plâtre, mises sur la peau, ont ainsi parfois permis, avec une aiguille indicatrice, d'aller trouver le projectile, mais le compas du médecin-major Hirtz rapidement décrit plus haut, m'a inspiré l'idée, plus pratique que de faire des calculs, de construire deux appareils semblables, deux compas s'appliquant à ces deux dernières méthodes. Pour celle de M. Hernaman Johnson, j'ai fait deux branches perpendiculaires qui portent chacune une autre branche perpendiculaire, cela permet de faire un rectangle à branches déplaçables : deux tiges viendront aux points A et C de la peau (fig. 3) les secondes tiges perpendiculaires à ces premières peuvent aller ensuite à leur rencontre réciproque par glissement dans les premières, extérieurement, la distance CO est reproduite ainsi automatiquement ; grâce à une troisième et quatrième tiges arbitraires, on peut prendre des points d'appui quelconques sur la peau, ce que réclament les chirurgiens, car le point d'incision fait, le repérage disparaît en quelque sorte ; il faut des points fixes autour ; la tige CO peut alors, avec la tige portant en A, servir de stylet au chirurgien qui ouvrira et enfoncera peu à peu la longueur CO repérée et fixée; si des organes essentiels ne lui permettent pas d'aller en ligne droite, un arc de cercle analogue à celui du compas de Hirtz lui indiquera cependant toujours sa direction.

Pour la figure 5, je la construis sur le papier, le compas d'épaisseur des sculpteurs m'a donné l'épaisseur de la région ou *e*, je porte les distances d et D parallèles séparées par une perpendiculaire égale à *e* et partant de leurs milieux. Un compas analogue au précédent, avec branches obliques angulaires, partant de A et de B vont alors se rencontrerten G, la pointe E poussée jusqu'n G mesure EG, la repère et servira ensuite au chirurgien de stylet comme précédemment, avec les pointes redressées et partant sur les points cutanés A et B, avec une tige arbitraire supplémentaire pour mieux asseoir le compas sur le patient toujours par trois tiges fixes, et la quatrième centrale, servant de directrice.

Dans ces conditions, mes compas suppriment tout calcul qui en général répugne aux médecins et aux chirurgiens. Malheureusement en raison de l'état de guerre, de la mobilisation des ouvriers, du surcroit d'occupation des rares constructeurs restant, mes compas ont été jusqu'ici des compas de fortune, dont je ne puis donner les figures. Je crois cependant que la description ci-dessus en est suffisante et que tout radiologue peut réaliser ces instruments. Les compas des boîtes à dessin pour enfants en fournissent facilement et sommairement les éléments essentiels.

Depuis le début de la guerre j'ai radiographié et radioscopé de nombreux blessés des trois sections de la Croix-Rouge française notamment de l'Union des Femmes de France dont je suis le Directeur de la radiologie des hôpitaux, c'est dire que souvent les données précédentes ont été appliquées, et que l'on me permette d'ajouter, avec succès, succès confirmés aussi par maints confrères.

SOME MINOR POINTS IN X-RAY MANIPULATION.

By Nelson K. Cherrill, Haslemere, June, 1915.

In response to the appeal made by the Editors, I venture to submit a few points connected with X-ray manipulation, which may, perchance, be thought of sufficient interest to justify their publication.

Localization.—One point which strikes me as important in connection with those methods of *localization* which depend on the use of screens, or of double image radiograms, is that no provision appears to have been made for determining the distance from the plate or screen to the mark made on the flesh to indicate the position of the vertical ray passing through the foreign body. When this mark is on a summit, so that the plate or screen can be both level and in contact with it, all goes well, and the "distance below the plate" is also the "distance below the mark." But when, as often happens in actual work, the mark is by no means at the top, it is necessary to ascertain its distance from the recording surface, as that distance must be subtracted from the total depth of the foreign body (as recorded by the observation) if, that is, an accurate measurement is required. This I have succeeded in doing, by making the mark by means of a little wafer which encloses a minute triangle of lead foil. This little bit of lead is clearly seen, either in the radiogram, or on the screen, and the displacement (if any) of its image forms the basis of the necessary calculation. To make these wafers I spread the little lead triangles about on a piece of paper, previously covered with gum or paste. A second piece of paper is then placed over them and the two rubbed into close contact. One side of this pancake is then treated with a thick solution of gum, strongly impregnated with aniline dye. When all is dry, the wafers are cut out with a punch so that a lead triangle is in the centre of each wafer. About 0.3 in. is a convenient size.

I use a brass ring on the end of a thin lath of wood (as described on page 9 of the January issue of the *Journal of the Röntgen Society*) to determine the position of the vertical ray passing through the foreign body. The mark is made by placing a wafer in the centre of the ring; this can be done with great convenience and accuracy by picking it up on a needle-point fitted to a handle, and if the skin, or the wafer, is slightly moistened a firm adhesion is at once obtained. The wafer can be left in place to serve as the surgeon's guide, or, should it be removed, the aniline in the gum makes a stain on the skin and the record of its position remains.

Movement of the Tube.—I notice that all the authorities recommend the first record to be made with the vertical ray, and then the second after a movement to right or left as the case may be. But I venture to suggest that this is not making the best use of the means at our disposal, for it is evident that the larger the displacement of the tube (and, consequently, that of the double image) the more accurate will be the ultimate measure of its depth. The calculation of the depth of a foreign body is dependent solely upon the known displacement of the tube at a known distance from the plate or screen, and is not in any way dependent on the angles which the displacing rays make with the vertical. I would therefore suggest that the most rational way of working is to move the tube *about* half the proposed displacement in one direction, and then *accurately* the whole distance to the other side. Taking four inches as the movement proposed by Dr. Hampson, this would give (if made on both sides of the centre) a total movement of eight inches, securing thereby twice the probability of accuracy, or, at any rate, halving the chance of error.

Scales and Calculations.—A "mathematical artist," if I may use such an expression, has constructed for me a set of scales which seem a veritable triumph of mathematical ingenuity, as they solve every problem connected with X-ray localization by simple inspection. The main scale is constructed for a displacement of the tube of six inches, and it gives, with all distances from tube to plate from sixteen to twenty-eight inches, the depth of the object by simple direct reading, accurately, to the second place of decimals in inches. This is supplemented by another scale, which, in case the tube is moved any other distance than six inches, gives, by simple inspection, the corresponding displacement of the image. Thus if, for instance, the tube be moved five inches and the displacement of the image is found to be 1.32 in., we see, by a glance at this scale, that the image *would have been displaced 1.58 if the tube had been moved six inches.* This enables the six-inch scale to be used with *any known* movement of the tube. Further, as it is obvious that the shadow image of any object is *exaggerated* (owing to the want of parallelism of the rays producing it) it may be advisable to know its dimensions accurately. A further scale has been provided giving the true horizontal projection of the image, thus enabling the exact size of the image to be noted.

No good purpose would be fulfilled by any attempt to reproduce these tables in the pages of the journal, as they would come out too small to be of any practical value, but if any firm or provider of X-ray appliances should think it worth while to publish them, I should be happy to supply copies for that purpose, for the benefit of any workers interested in them.

Revolving Diaphragm.—Every photographer knows that the worst position of the camera for getting a clear picture is that in which it is made to face the source of light. Unfortunately X-radiograms have to be taken under this worst condition, the source of radiation being directly in front of the plate. Though very different causes may be at work in the two cases, the results are, in many points, very similar. A kind of veiling or fog prevails in radiograms when, by reason of a large aperture in the diaphragm, more rays than are necessary to the production of the image enter the field of view. This is explained by the impact of the X rays on surrounding objects setting up secondary radiations which also are able to affect the photographic plate. Of course, what is really wanted is a plate which is sensitive to X rays, but not to secondary ones. Whilst waiting for this to be invented, the best remedy is to use the smallest opening of the diaphragm compatible with getting the desired parts in the view. And I find that for this purpose a revolving diaphragm is invaluable.

The ordinary rectangular diaphragm is *fixed*, so that the parallelogram of light which it shows on the screen is always " square " with the couch. This may be all well enough when the limb or part under examination can be placed exactly parallel with the length of the couch, or at right angles to it, but, in practice, there are many cases in which this is difficult, if not impossible. With the revolving diaphragm it does not matter in what position the limb is placed, as the parallelogram of light can be turned to any angle to suit the position, and this enables the diaphragm to be closed down to the smallest useful opening, the disturbance of secondary rays being thereby reduced to a minimum.

The revolving arrangement I have made is very simple. It consists of a wooden ring screwed to the top of the tube box, a second ring, which just fits over this, is fixed to the plate of the diaphragm, so that this latter, when in place, will turn freely in any direction. A wooden handle serves to regulate the position required with speed and accuracy.

Sand Bags.—I find linen bags, about half full of sand, to be a great help in such cases as those in which the diaphragm cannot be arranged to cut off all the superfluous rays—*e.g.*, an elbow bent at right angles, or a foot seen sideways. The bags, not being full, can be easily moulded on the couch to any shape to fit the outline of the parts under observation. The sand completely stops the X rays, and hence plays the part of an extension of the diaphragm.

Centring the Tube.—Many makers of apparatus supply costly devices for this purpose. One I designed, which gives quite satisfactory results, is of the simplest. It consists of a cross of rounded wood half an inch in diameter. On the four arms of the cross are slipped four brass curtain rings (one on each arm). These are brought near to the centre, so that the opposite pairs are about an inch apart. This little appliance is placed *level* on the couch and is then covered with the screen. The diaphragm is reduced to give a square of light of about one and a half inches, and the tube is then moved about till the image of the cross falls central to the patch of light. If then, the point of emission is *central to the diaphragm*, the four rings will have the appearance of *straight lines*, but if it is not central, one or more of the rings will show an ellipse and the tube must be shifted in the box accordingly.

Quick drying of a Photographic Plate.—It is not generally known that a plate can be dried in a few minutes by plunging it into a *saturated* solution of potassium carbonate. I am indebted to Mr. Sinclair's little brochure, " The Sign Post," for this hint, and find it a most excellent one. The manipulation is delightfully simple. If in a hurry, the plate can be washed under the tap for a minute after coming from the hypo. The surface water may then be removed by a " squeegee " and the back wiped with a cloth. It is then laid in a dish and the saturated solution poured over it. In four minutes the plate may be removed and wiped back and front with a cloth. The film will be found quite hard and *dry*. Why putting a wet film of gelatine into an aqueous solution of anything should *dry it* is a puzzle of which I can offer no explanation, but the fact remains that in this case it is so. To succeed, the solution must be *quite* saturated, and to that end it is well to keep some crystals of the salt undissolved in the bottle. The solution may be used many times.

REPORT OF SOCIETY.

RÖNTGEN SOCIETY

PROTECTION OF THE X-RAY OPERATOR.

The annual general meeting of the Röntgen Society was held at the Cancer Hospital (Free), Fulham Road, on June 1st, under the presidency of Sir A. Pearce Gould. The annual report stated that in spite of abnormal conditions, the work of the Society had been continued and extended, and that although the Dosage Committee had been unable to complete its labours, an interim report would be published in the October number of the Society's Journal. The financial statement was equally satisfactory. On the election of officers for 1915-16, Mr. J. H. Gardiner, F.C.S., was made President, Mr. W. Duddell added to the list of vice-presidents, and Mr. Geoffrey Pearce called to the duties of treasurership in place of Mr. C. E. S. Phillips, who had had to relinquish the office owing to his increasing duties. Dr. R. Knox was re-elected honorary secretary.

A paper on the subject of localisation of foreign bodies was read by Dr. John H. Shaxby, R.A.M.C. The method he brought forward would need a very full description to make it intelligible, and readers must be referred to his printed paper. Briefly, his method was one which did not supplant but merely supplemented the familiar methods of triangulation. Instead, however, of the ordinary method of moving the bulb parallel to the plate upon which the photographs are taken, Dr. Shaxby follows the plan of moving it perpendicularly to the plate, and instead of having the foreign body as nearly as possible over the anticathode, he has it distinctly to one side. The method only involved a fairly simple form of calculation. Dr. Ironside Bruce again exhibited his couch and X-ray detector for leading down directly to the foreign body, as already described in the Archives (April, 1915, page 399).

The chief event of the evening was a discussion on the methods of protection of X-ray operators. Sir A. Pearce Gould pointed out the great importance of this subject at the present time. With so large a number of new X-ray installations making their appearance, and being placed under the control of men who had had necessarily scanty experience, and who had to work under conditions of great pressure and strain, it was evident that a new peril confronted us. He hoped that, as a result of the discussion, this matter would be brought very effectively under the notice of those in authority. If the War Office would let the Society have one of their X-ray equipments, they would add protective elements to it, and it would then be a demonstration of what the Society believed to be the best way to protect workers from harm.

Dr. Sidney Russ gave some measurements he had been making in lead rubber and lead glass in order to test their efficiency. In the case of lead rubber, he illustrated the variations that occurred by comparing samples submitted by three manufacturers.

With some installations as much as 5 per cent. of the energy coming from the bulb penetrated through to the other side of the protective material, and it should be remembered that in the course of screen examination, with which he was dealing, the worker stood very close to the bulb. He had selected for the purpose of experiment a bulb running at a hardness very usually employed during screen examinations.

The thing that struck one in the case of lead glass was that the amount transmitted depended to a very much greater extent upon the quality of the glass than upon the thickness. Thus 4 per cent. of radiation was sent through one screen 5 mm. in thickness, and only 3·4 per cent. through a screen having a thickness of 3·65 mm. It was of no use assuming the efficiency of the glass by virtue of its thickness; only its density would give a correct idea of its absorptive power.

Mr. C. E. S. Phillips referred to the early researches of Faraday, who had produced a very dense glass, using biborate of lead, and suggested that for the purpose of X-ray protection it might be possible to raise the question with the glass makers as to the production of specially dense glass.

Dr. G. B. Batten commented upon the difficulty of getting hold of good glass and of good rubber. The attitude of the average manufacturer of X-ray apparatus was that any kind of protective glass and any kind of protective rubber would answer the purpose, and such hard rays as did come through were neglected, yet they did get a certain amount of X-ray excoriation and warty growth unless one was careful to stand a long way from the tube.

Mr. J. H. Gardiner raised the question of secondary rays, pointing out that wherever X rays were produced there was an immense number of secondary rays in the neighbourhood. He thought the most efficient form of protection would be to enclose the tube completely in thoroughly efficient and heavy lead glass. The prevailing method of just protecting the tube in the neighbourhood of the anticathode was not proof against these vagrant radiations.

Dr. N. S. Finzi also urged the importance of always enclosing the tube as completely as possible and using the smallest diaphragm so as to diminish the secondary radiation that came out all round the walls.

Mr. C. R. C. Lyster moved, and Dr. G. B. Batten seconded, "That in view of the recent large increase in the number of X-ray installations, this Society considers it a matter of the greatest importance that the personal safety of the operators conducting the X-ray examinations should be secured by the universal adoption of stringent rules." This was carried unanimously, and it was added that the Council of the Society would meet at an early date in order to take further steps towards this end.

Subsequently the members visited various parts of the Cancer Hospital, where a number of demonstrations of apparatus and interesting exhibits had been arranged for their benefit. The laboratory under the control of Mr Phillips was open to inspection, and also the X-ray building, where the Coolidge tube and a new transformer were shown at work. Elsewhere there was on view a collection of radio-active ores containing radium, a number of emanation vessels, and various X-ray prints and negatives, some of which were viewed by means of the Wheatstone stereoscope.

REVIEW.

Pyelography (*Pyelo-Ureterography*). *A Study of the Normal and Pathologic Anatomy of the Renal Pelvis and Ureter.* By WILLIAM F. LE BRAASCH, M.D., Mayo Clinic, Rochester, Minnesota. Containing 296 pyelograms. Philadelphia and London: W. B. SAUNDERS COMPANY, 1915. 21s. net.

A perusal of this comprehensive monograph on pyelography cannot fail to be profitable to the practising physician, surgeon, and radiographer. Each will find in the mass of clinical data much food for reflection, and when the contents of the book have been mastered the reader must have greatly increased his diagnostic knowledge.

The publication of a book on this highly specialised branch of radiography will add much to the reputation of the author, and also to that of the radiographers who have aided him in the production of so many skiagrams of a high degree of excellence. The book as a whole is an admirable testimony to the thoroughness which characterises all work done at the Mayo Clinic.

It also serves to draw attention to the great advances which have taken place over the whole field of radiographic research. It is probable that in the future the most useful form of publication in these branches will be of the nature of monographs rather than of text books.

The author in his preface says:—" In all this time no comprehensive collection of the various types of pelvic outline has been published." From a collection of several thousand plates at the Mayo Clinic he has selected 296 pyelograms to illustrate the normal and abnormal condition of the renal pelvis and ureter.

We think he has admirably succeeded in presenting to the reader a most comprehensive and convincing thesis, which, while it must be of immense service to the physician and surgeon, is also of the greatest value to the Roentgenologist who wishes to add to his knowledge on many points of diagnostic value in this branch of his work.

A careful scrutiny of this monograph cannot fail to impress even the uninitiated with the immense value in diagnosis which this highly specialised branch of radiography possesses; the only analogue is the opaque meal in the diagnosis of various conditions of the alimentary tract. Both serve to demonstrate the great value of radiography in the diagnosis of disease in the hands of the skilled expert.

A consideration of the 296 pyelograms convinces one of the great need for highly trained skill in order to produce such striking results. It is essential that a competent cystoscopist should work in conjunction with the radiographer, and both must be very expert to get such good results.

In the reproduction of the plates some objection may be made to the irritating, and to our mind quite unnecessary, habit some radiographers have of disfiguring their best plates by having a case number written across the plate. The impression given by an inspection of the plates is that the reproductions in many instances have failed to give an adequate representation of the original negatives.

An excellent chapter on the history of pyelography gives in chronological order the development of the technique. It deals also with the accidents which have occurred, and indicates the manner in which these may be avoided. Fatalities have been recorded due to poisoning by silver salts. One case showed silver salts embedded throughout the tissues, another where the patient died from shock. Rupture of a hydronephrotic sac may also occur.

The author summarises the value in diagnosis in the following conditions:—(1) Normal renal pelvis. (2) Hydronephrosis. (3) Pyelitis. (4) Pyonephrosis. (5) Renal tuberculosis. (6) Renal tumour. (7) Renal and ureteral anomaly. (8) Monocystic and polycystic kidney. (9) Identification of renal shadows. (10) Localization of renal shadows. (11) Identification of ureteral obstruction. (12) As an aid to ascertain renal function.

This summary may be said to include practically all possible conditions in which the method has been found to be of value, and gives an indication of the scope and thoroughness of the monograph. The author has done a great deal of original work in pioneering this useful method, and has succeeded in placing before the profession a comprehensive summary of the history and development of pyelography and its technique. In the preface he fittingly acknowledges the work of Drs. A. and B. Moore and of Mr. E. L. Taylor, of the Roentgenographic Department at the Mayo Clinic.

The chapter concludes with the following:—" It is very evident that unless a pyelogram is made with strict technical precautions it may cause considerable injury; however, in the hands of those familiar with the necessary technique and the selection of cases, it has been proved to be a comparatively harmless procedure. Thus, the writer reported a series of over 1,000 pyelograms made without serious results to any patient. The method is too valuable in the diagnosis of many conditions in the urinary tract to be discarded. Efforts should be made, however, to discover a substance which will not injure the kidney under any circumstances, and which may be safely employed in the hands of those with limited experience." The chapter concludes with an excellent bibliography, which will be found most useful by all who desire to take advantage of this method of examination.

Chapter II deals with technique. After a few preliminary remarks the author proceeds to the discussion of the selection of cases, selection of the medium employed, the preparation of the patient and of the solution.

The method of injection is carefully described; the use of a hand syringe is not advised, pressure of gravity is better. The one thing missing in this chapter is a diagram of the apparatus used, which would have helped to clearly illustrate the method employed.

The dangers incident to its use and the necessary precautions are clearly placed before the reader. Sources of error are pointed out; these may be due to either the radiographic or cystoscopic technique. A point of great importance is that unless the facilities for making a good radiogram are at hand a pyelogram should not be attempted.

Injurious results are fully dealt with. The technical errors have usually been :—(1) Forcible distension of the pelvis. (2) Long continued pressure. (3) Trauma of the pelvic mucosa.

Gas Pyelogram. — Theoretically air or oxygen would be admissible substitutes for any opaque fluid, and would obviate the disagreeable features of the latter. This method is not recommended in preference to the opaque fluid for several reasons.

Chapter III deals with the normal renal pelvis. It is copiously illustrated by forty-six beautiful examples of radiography, many of which are works of art; we would particularly call attention to Fig. 30, illustrating the normal pelvis in both kidneys. This chapter includes practically all variations of the normal renal pelvis and ureter, and shows the variations due to positions of the organ. As a valuable aid to the interpretation of the normal renal pelvis this cannot fail to be extremely useful to the physician and surgeon.

Chapter IV deals with abnormal position. The position of the normal kidney is not fixed, and it is difficult to place any arbitrary limits to the extent of normal change in position. The author deals with departure from the normal position fully. Practically all departures are dealt with and illustrated by pyelograms.

Renal torsion is then fully dealt with. Fig. 64 shows a renal pelvis situated at an unusual distance from the vertebral border. The author points out that this condition might be explained by the lateral development of the entire kidney as a result of torsion.

Dystopic or Pelvic Kidney.—The author points out that a moderate deviation from the normal condition, or even a freely movable kidney is not necessarily considered a congenital anomaly; when, however, the kidney is found lying fixed to the bony pelvis, and when the blood supply comes from adjacent arteries, it must be regarded as a true congenital anomaly. He makes the point that the pyelogram offers a better means of distinguishing the condition than the use of the opaque catheter. There are many other interesting diagnostic points in this section of the book.

Fig. 65 illustrates the dystopic kidney opposite the lower portion of the sacrum. The course of the ureter in this case is short, and the outline of the kidney is small, indicating evidence of atrophy.

Chapter V deals fully with mechanical dilatation. Here the author gives evidence of a thorough clinical knowledge. He describes the systematic investigation of the renal pelvis, and enters fully into many differential points in diagnosis which cannot fail to be of value to the reader. He says, " the renal pelvis, as well as the ureter, may become dilated as a result of the following conditions:—(1) Mechanical obstruction. (2) Infection. (3) Tumour."

A full description of the changes in the pelvis follow.

Hydronephrosis.—In this condition the pyelograms give ample evidence of the great value of this method of investigation. Under early hydronephrosis the important question of the degree of distension is discussed. The normal capacity is stated to be from 5 to 10 ccs., and all degrees of over distension may arise. He says, "In order therefore to demonstrate the exact condition found, the outline of a well distended pelvis, as seen in the pyelogram, may be of more definite diagnostic value than any other data. Full descriptions of many variations from the normal follow, and the definite significance of each in diagnosis is fully discussed. A most interesting feature of this section is the pyelogram showing the condition of both renal pelves side by side. This enables one to at once realise the degree of dilatation present.

Side by side with various degrees of dilatation the author shows some abnormal and normal cases; conditions which are on the border line, and gives good reasons for classifying these as normal types. The normal and abnormal appearances of the calyces are fully described. "A point of interest in the diagnosis of hydronephrosis of early or moderate degree is the change frequently seen in the angle at which the ureter leaves the pelvis."

Then follows descriptions of moderate hydronephrosis and large hydronephrosis, all cases and degrees being beautifully illustrated by pyelograms.

Variations in the size and length of the ureter are next described. Under the heading, "Intra renal Hydronephrosis," the author describes a condition where the dilatation may be confined largely to the calyces.

Inflammatory Dilatation. — Thirty-eight pages and forty-two illustrations are devoted to the description of inflammatory dilatation.

Pyelitis and pyonephrosis are carefully described and discussed. The following characteristics are given:—(1) General irregularity of outline. (2) Predominance of dilatation in the calyces rather than in the true pelvis. (3) Clubbing and rounding of the calyces.

Each of these subdivisions is fully dealt with and illustrated by instructive pyelograms. The forms of dilatation of the ureter are also fully discussed.

The Ureter and Ureteritis.—As with inflammatory changes in the pelvis an inflammatory process in the ureter is followed by tissue changes in its walls, which cause more or less dilatation.

Renal tuberculosis is fully dealt with in this chapter. The author claims that the pyelogram may be sufficient to establish a diagnosis of tuberculosis, but also makes the point that only in cases where other methods fail should this method be employed. The changes in the pyelogram found to accompany renal tuberculosis will be as follows:—(1) Dilatation of the pelvis. (2) Areas of cortical necrosis. (3) Stricture of the ureter. Fig. 149 shows renal tuberculosis with pyonephrosis.

Renal Stone.—The greatest problems in the interpretation of shadows in the kidney are their identification, whether they are intra or extra renal, and their exact localization (if intra renal in what portion of the kidney). The pyelogram will be of considerable aid in the solution of both problems.

The discussion of these interesting conditions occupies forty-three pages, with fifty-five illustrations. Many beautiful examples of stone are shown, some without the injection of fluid, the majority with it show the relationship of the stone shadows to that of collargol. Fig. 201 illustrates the relationship of a gall-stone to the pelvis of an injected kidney.

Under the heading, "Shadow Identification," the author concludes that the data obtained by means of cystoscopic inspection and the ureteral catheter are often sufficient for the identification of the stone; in other cases shadows can be identified by means of the pyelogram. The method should not be employed as a routine procedure, however, but be used only when interpretation is doubtful or when exact localization is desirable. The pyelographic data which will enable us to determine whether a doubtful shadow is extra or intra-renal are as follows:—(1) The distance separating the shadow from the pelvic outline. (2) The exact relation of the shadow of the pelvic outline. (3) The presence of pathological changes in the pelvic outline. In some cases a stereoscopic pyelogram may be useful in determining doubtful points.

Absence of Stone Shadow.—The author says, "When the consistence of the stone shadow is soft, in the presence of a large amount of abdominal tissue, and with imperfect radiographic technique, renal stone may not be detected in the radiogram. In such cases the pyelogram may occasionally demonstrate the changes in the pelvic outline which usually accompany renal stone, and with this evidence further efforts directed towards the radiographic examination of the stone may be successful. Moreover, it has been found that solutions of colloidal silver will coat the surface of the stone to such a degree that it will cast a shadow. If a radiogram is made on the day following a pyelogram the outline of a stone overlooked in a previous radiogram may be rendered visible by the coating of the silver."

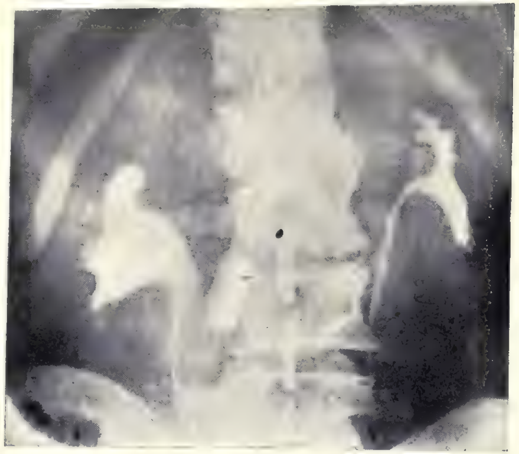

Fig. 119.- Inflammatory dilatation.

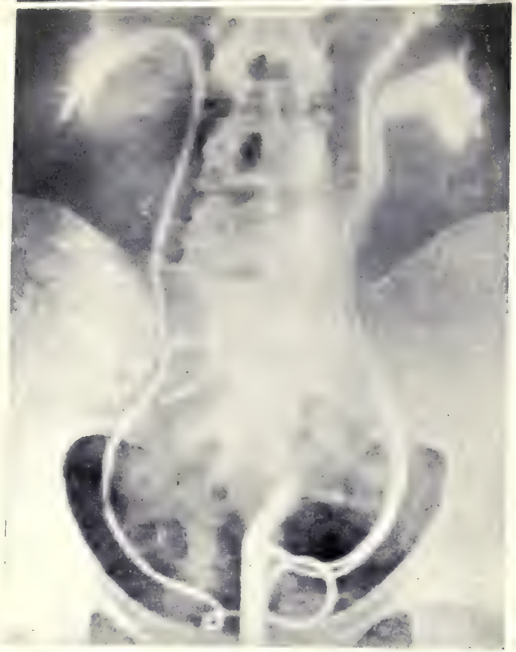

Fig. 288.--Duplication of Ureter and Pelvis.

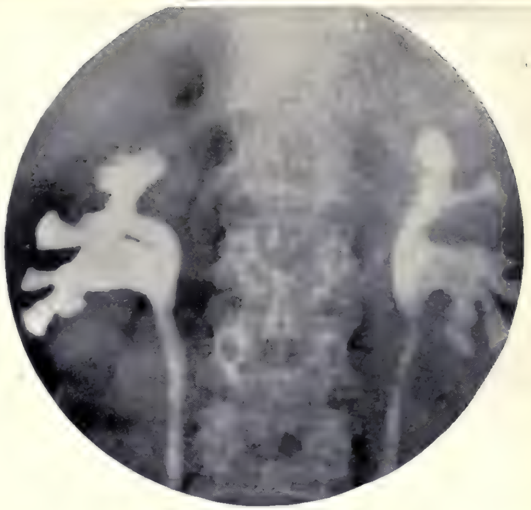

Fig. 30.—Normal Pelvis.

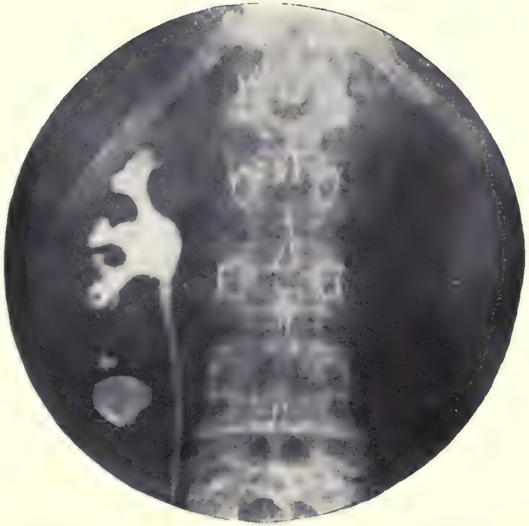

Fig. 201.—Shadow Identification (Gall Stone).

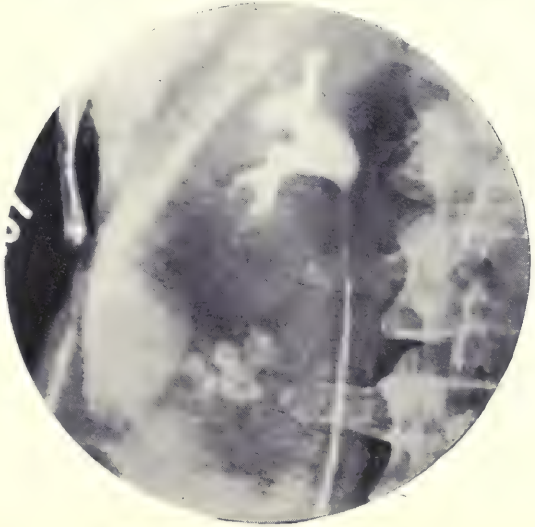

Fig. 195.—Multiple Gall Stones.

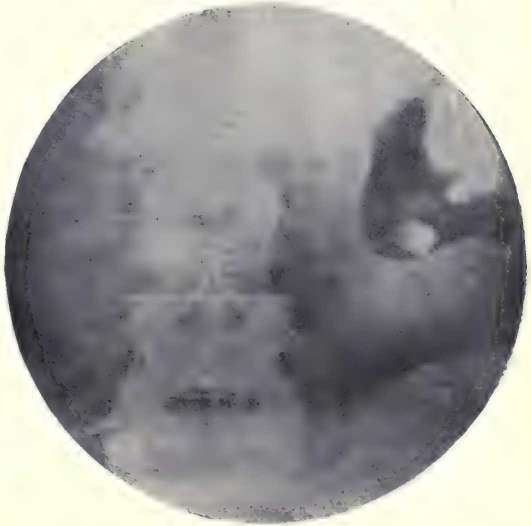

Fig. 174.—Renal Stone (Oxygen Pyelogram).

Plate 18.

From Braasch's "Pyelography." Reproduced by kind permission of the Publishers.

Shadow Localization.—This important matter is of the greatest value to the radiologist; the subject is fully discussed, and the pyelograms shown in cases which had previously been radiographed—the exact position of the stone may be determined by the method. The value of this information to the surgeon prior to operation is emphasised. It is possible to state definitely when a stone lies in the pelvis, calyces, or cortex of the kidney, and when it is situated in the pelvis the degree of obstruction to the outflow of urine may be approximately estimated.

Ureteral Stone.—This very important subject is fully dealt with, the differential points being carefully explained. The importance of being able to determine whether a shadow is intra or extra ureteral is of the greatest importance, and an explanation of the causation of the extra ureteral shadow would have been welcome; no such explanation is given. Possibly the author, in common with a number of radiographers, has not yet arrived at a satisfactory explanation of the shadows.

Gall Stones.—The differential diagnosis is fully discussed and shown in a number of pyelograms.

Chapter IX. This is devoted to a consideration of renal tumour. The differential diagnosis is fully entered into, particularly in so far as pyelography may aid in the elucidation of obscure cases. Many of the illustrations shown are very convincing evidence of the value of this method which should be carefully borne in mind. He, the author, advocates its use only in those cases where other methods have failed to give conclusive evidence. This chapter concludes with a short account of cases where the ureter may be involved by or pressed upon by a tumour.

Chapter X deals with congenital anomaly. The following are given as likely to be demonstrated by means of pyelo-ureterography.

(1) Duplication of the renal pelvis.

(2) Duplication of the ureter.

(3) Fissured or horseshoe kidney.

(4) Congenital increase or decrease in size of the kidney.

(5) Dystopic kidney.

CORRESPONDENCE.

29, Poole Road,
Bournemouth, W.
25th June, 1915.

To the Editors of the Archives of Radiology and Electrotherapy.

Dear Sirs,—It would, I think, be very convenient to the majority of us practising radiology and electrotherapy to have a list drawn up containing the names and addresses of men in Great Britain specialising in these subjects.

Usually, if one does not happen to know whether a certain town boasts of a radiologist or electrotherapist, it is necessary to hunt through the hospital staff lists in the "Medical Directory" when advising a patient whom to consult in a certain district.

Yours faithfully,
Claude Saberton.

[Dr. Saberton calls attention to a need which we hope to fill in the near future.—*Editor.*]

To the Editors of the Archives of Radiology and Electrotherapy.

Sirs,—In the June number of your journal, in an article entitled, "The Inhibitive Effect of X rays upon Malignant Growths," Dr. Kempster puts forward the proposition that, in the treatment of new growths with X rays, better results are obtained by giving a dose sufficient to stop the proliferation of the cancer cell than are obtained by giving a dose which kills the cancer cell outright; in one case the healthy surrounding tissues will be uninjured, in the other they may suffer injury.

This statement of opinion is based on the following observations. Sections of an epithelioma after eight irradiations (dose not mentioned, nor how long after exposure the sections were taken) show no particular evidence of cell destruction, but present evidence of the disappearance of cancer cells.

Quotation—"In fact, I do not find any particular evidence of destruction of cells at all . . . but there is certainly evidence of the disappearance of malignant cells, the downgrowths being interrupted in places, and isolated islets of epithelial cells, old and young, are found here and there cut off; the intervening spaces are filled with small cell infiltration which has, in fact, been converted into connective tissue."

These two observations are, to a large extent, contradictory, for if cancer cells have disappeared they must have been destroyed; and until they have disappeared it is by no means always easy to be sure that they have been killed. Profound degenerative changes would, no doubt, justify the statement that the cells were dead, but on the other hand dead cells may present histological characters little if at all removed from living cells. The disappearance of cancer cells after irradiation may or may not be preceded by obvious degenerative changes; this also occurs in the tumours of animals which are spontaneously disappearing; and the exact mechanism of tumour retrogression is still undecided.

Although Dr. Kempster's experiments do not, it would seem, support his contention, nevertheless they remind one that even if it is not possible to destroy the cancer cell by means of X rays, and leave the normal cell relatively uninjured, it may be possible to control the growth of the cancer cell and thus allow or encourage the normal cells to deal with the cancer cell by an immune or other natural process.

J. C. MOTTRAM.

The Middlesex Hospital,
Cancer Research Laboratories.

NOTICES.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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RADIOTHERAPY: ITS SCIENTIFIC BASIS AND ITS TEACHING.

By J. Joly, ScD., F.R.S.

[Read March 23, 1915, reprinted by kind permission of the Council of the Royal Dublin Society.]

The recent discovery that X rays and γ rays can be defracted into spectra by the natural grating contained in the orderly structure of crystals, sets at rest the question as to the nature of these radiations. They are of the same nature as light-waves, but of very much higher frequency—from 10,000 to 100,000 times as high.(1)

Such rapid vibrations do not evoke the sensations of sight. Our tissues are, indeed, to a considerable degree, transparent to them; the power of penetration increasing with the frequency or as the wave-length diminishes. Whereas light-waves are rapidly absorbed within a few millimetres of the surface of the skin, these rays can penetrate deeply; some of the highest frequency even passing right through the body.

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(1) The wave-lengths of these various rays are of the following orders:—light, 10^{-5} cms.; X rays, 10^{-8} cms.; γ rays, 10^{-9} cms.

The certitude of the identity of these three classes of radiation leads to issues of much importance to medical science. For medicine had for many years been invoking the aid of the mysterious X and γ rays without in the least knowing what these agents were. It now turns out that they are physically identical with light. This fact secure, medical science is made heir to the discoveries of photo-electric science. It is for the physician now to enter into his inheritance, and to see what it teaches him as to the interpretation of his past results and as to openings for future advance. I shall restate the leading facts of photo-electric science.

In 1887 Hertz noticed that the passage of an electric spark between the terminals of an induction coil was much facilitated by the discharge of another spark in its neighbourhood. He showed that the light from the spark was the agent which promoted the discharge. Ebert, the ensuing year, found that the action of the light was on the cathode, and Hallwachs made the important discovery that light could discharge a negatively electrified body, but not a positively electrified one. The discharge was chiefly due to the ultra-violet waves.

Hallwachs' experiment is an easy one to repeat. It is of fundamental importance to photo-electric science. A convenient arrangement is to connect a polished plate of zinc to a gold-leaf electroscope and use an arc light to radiate to it. If we charge the gold-leaf and zinc plate negatively and then turn the light on the zinc, the leaf rapidly collapses. If we charge the system positively, we get no effect from the light. The insulation—best of sulphur—must be carefully attended to, and no bright light allowed to fall upon it.

We can detect the photo-electric effect without first electrifying the illuminated plate. A carefully insulated plate, brightly lit from a source rich in ultra-violet rays, will acquire a positive charge. This charge will rise to a certain potential dependent on the character of the light, and will rise no more.

These results find explanation in the emission of negatively electrified particles from the illuminated plate. If the plate is negatively electrified to start with, the expulsion of the particles is facilitated. If it is positive, they are attracted back and there is no effect. If the plate is neutral to start with, the loss of negative electrons gives it a positive potential. This increases till the attraction is such as to keep back the negative particles. Beyond this it cannot increase.

Since the date of these pioneer experiments much has been ascertained regarding the nature of these negatively electrified particles and the conditions under which they are liberated. In this *résumé* we cannot, of course, enter into details. The leading facts may be stated as follows:—

(1) The particles expelled carry each a negative charge of the unit amount—in other words, the Faraday unit which appears in electrolysis and in the determination of the valency of the elements.

(2) The particles are alike in mass, no matter from what elemental substance they may be evoked. This mass is very much less than that of a hydrogen atom—about the thousandth part. They are identical with the "electron," with the "corpuscle," with the "β ray," and with the "cathode ray."

(3) The number liberated by the action of light in unit time is directly proportional to the intensity of illumination.

(4) The energy with which they are discharged is independent of the intensity of the light, and is directly proportional to the frequency—*i.e.*, the greater the frequency the greater the energy of the photo-electrons. Or, we might say, the shorter the wave-length the greater the velocity of the electron.

(5) The effects are independent of the temperature, taking place freely at the temperature of liquid air.(1a) The effect is, therefore, an inter-atomic and not a chemical one. Chemical actions cease at such temperatures.

These are the fundamental laws of photo-electricity. To-day we are in a position to extend these laws to the much shorter and more rapid oscillations of X and γ rays.

It much conduces to a clear understanding of the relations of the several parts of the subject before us if we take into account a comparatively recent generalization which applies to all æthereal radiation—heat, light, X ray, or γ ray. The generalization is due to Planck and Einstein.

According to Planck, the energy of radiation is not sent into the æther as a continuous stream, but in "fits" or discrete rays. The total energy, for instance, which reaches the leaf of a plant from the sun in a second of time is composed of an integral number of definite elementary units of radiation or vibration. The energy associated with each unit of radiation he calls a quantum of energy; and he shows that this is always equal to a certain universal constant multiplied by the frequency. This constant (Planck's constant) has the value $6{\cdot}55 \times 10^{-27}$ erg seconds. If n is the frequency of any æthereal radiation—light, X rays, or γ rays—we can say that the energy of the quantum is $n \times 6{\cdot}55 \times 10^{-27}$ light unit. Such units of energy move in space without spreading or dividing. They keep their discrete and separate character wherever they travel.

The important matter for us to notice here is that the energy increases directly with the frequency. Now, the frequency of an X ray may be 10,000 times that of a light-wave; hence the quantum of energy associated with it may be 10,000 times greater. And as a γ ray of radium C may be of 100,000 times the frequency of a light-ray, the quantum of energy associated with it may be 100,000 times greater, and 10 times as much as accompanies the X ray.

These facts enable us to assign an explanation to some of the laws of photo-electricity which we have recorded above.

We have stated, as matter of observation, that light gives rise to a discharge of electrons, or β rays, from substances in which it is absorbed, and that the velocity and energy of the discharged electrons are proportional to the

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(1a) Joly, "Nature," vol. lxxii, p. 308, 1905.

frequency of the light employed, and are not in any way dependent on the intensity or brightness of the light. This at once follows, if we assume that each expelled electron absorbs one quantum of energy, and with this store starts upon its path. The number of quanta falling per second upon unit area of the substance increases, indeed, with the intensity, but each individual quantum remains the same in amount; and thus while the number of electrons liberated from the illuminated surface increases with the intensity, the velocity of the electrons is determined entirely by the value of n.

The fact that γ and X rays give rise to very fast and penetrating β rays when the former are absorbed in matter has, for some years, been known to science, and we are able to state that here, too, and over a much greater range than that of the whole visible spectrum, the law obtains that the velocity of the expelled electron increases with the frequency. What is more, we are safe in stating, from the law of quanta, that such β rays greatly exceed in energy those expelled by light-waves; and we are thereby enabled to give an explanation of their observed much greater power of penetration.

The mechanism by which a light, a γ, or an X ray is transformed into β radiation is unknown. It is most certainly an inter-atomic process; that is, it is consummated within the atom. Whatever the explanation may be, it must involve a reciprocal or reversible mechanism; for it is established that the β ray can give rise to the γ ray, the quantum of energy being handed from one form of activity to the other.

In the case of light a similar transformation explains—according to Einstein, Lenard, and Saeland—the phenomena of fluorescence and phosphorescence. Here the light-wave, imparting its energy to the electron, liberates it from the atom. The electron after a longer or shorter sojourn in the precincts of the parent atom is finally attracted back—a return which may be accelerated by the agitation involved in a rise of temperature. The disturbance attending the return of the electron to the atom sets up vibrations of visible length, and, in fact, gives rise to the phenomena of phosphorescence and fluorescence. These vibrations represent the restoration into æthereal waves of some of the original luminous energy. The fact that there is some loss of energy in the processes of transformation involves smaller quanta in the final luminous vibrations and hence longer wave-lengths. This realizes Stokes's law, which defines the wave-length of the fluorescent light to be longer than that of the exciting light.(2)

In the X-ray tube the electric force between cathode and anticathode sends a stream of fast moving electrons from the one to the other, and it is where this stream impinges on the atoms of the anticathode that X rays are generated and fresh β rays or electrons are liberated. Each of these X rays carries its quantum of energy depending on its wave-length or frequency, and is in kind identical with the γ ray emitted by radio-active elements; but the quantum is less than is generally associated with the γ ray. It is now known, also, that the X rays from the anticathode are evolved in

(2) Einstein, "Ann. d. Physik.," Bd. xvii, 1905. Lenard and Saeland, "Ann. d. Physik.," Bd. xxviii, 1909.

spectra characteristic of the nature of the element forming the material of the anticathode.

The increasing gradation of energy from the wave of light to the γ ray introduces certain differences into the phenomena they give rise to. This must be held in mind, for these differences may be important therapeutically. I shall refer here to two important instances.

(1) Photo-electric effects appear in certain cases to be limited by chemical structure. Thus the sulphides of the metals yield free electrons under light stimulus; the corresponding sulphates do not. There is, however, no such limitation when the electrons are evoked by X or γ rays. The limitation imposed in this case by chemical structure almost certainly arises from the small velocity with which the photo-electrons are emitted. There is no reason to believe that light fails to evoke the electron, but the molecular structure is such as to secure a large absorption.

(2) Outside the region of the ultra-violet, but long before the higher frequencies of X rays are reached, there is a spectral region which has been named the Schumann region. This is concerned with wave-lengths of from 2,000 to 1,500 Angström units (10^{-8} cms). The absorption of these waves in air, water, etc., is very rapid—far more so than that of visible light. To these waves we will again refer. The point in the present connection is that the greater frequency has not been attended with increased penetration. This may be due to resonance with some harmonic of the atom. Selective absorption by matter is a conspicuous phenomenon in the case of waves of low frequency. Dealing with such waves, it must not be forgotten that media may be sensitized for particular rays by adding photo-electric substances which absorb those rays. Thus photo-electric effects on bacterial culture can be greatly increased by the addition of eosine or similar dyes.

The β and γ radiations given out by radio-active bodies are those which most concern us. I cannot stop to discuss the views which have been offered as to the source of these radiations in the atom and the kind of properties which must be ascribed to the atom in order to account for the origin and interchange of quanta within it. Suffice it to say that Rutherford has defined in general terms the necessary conditions.(3) Nor is it possible here to do more than mention the facts that the γ radiation given out by radio-active atoms shows continuous as well as line spectra and that the β radiation of such atoms possesses a varied distribution of velocity which, when analyzed by the deflecting influence of a strong magnetic field, gives rise to a linear "spectrum" of velocities, superimposed on a continuous "spectrum" of velocities. Further, it can be shown that the energies characterizing the lines in the "spectra" of the primary β particles escaping from a radio-active atom—for instance, Ra C—are such as would be derived from an integral number of the quanta associated with certain lines of the γ-ray spectrum emitted by this same element. Hence the emission of trains of waves (and of quanta) from such atoms is indicated; ten or even more waves entering into the train according to the nature of the

(3) Rutherford, Phil. Mag., vol. xxviii., Sept., 1914.

atom and the frequency.(4) Under suitable conditions the train of waves may give all its energy to a single high-speed electron. The high penetrating power of the β particle excited in matter by the γ ray has, according to this view, its source in the peculiar structure of the γ ray emitted by the radioactive atom.

The foregoing statements define in a brief—perhaps too brief—manner the fundamental facts of photo- and radio-electricity. The most important of these facts to carry in mind is the convertible nature of the two sorts of radiation—the electronic and the vibratory. It helps our assimilation of the laws governing this interchange to remember that the activity involved in the γ, X, or light rays is parcelled out into definite quanta which are much greater for the high frequencies than for the low; so that the β rays originating in the interchange possess much more energy in the one case than in the other.

We must now direct our attention to the electron and its influence in bringing about molecular changes. Here, again, we deal in quanta—although differing in kind from the Planck unit. For Faraday long ago showed reasons for assuming that electric currents attending chemical or molecular changes moved in quanta: the Faraday charge on the ion, which—as we have already seen—is the same in amount as that which is associated with the electron. Thus we find Nature on every side ultimately ordered in discontinuous units.

The simplest case in which we can study the effect of the electron is when it is liberated in a gas—say, air. Each electron liberated from an atom of oxygen or nitrogen leaves this atom positively electrified by one unit charge of positive electrification. The atom becomes a positive ion. The electron soon attaches itself to one or more atoms, and in doing so creates a negative ion. If now an electric potential is established—say, between two electrified plates contained in the gas—the plus electrons move towards the negative plate and the negative electrons towards the positive plate. Finally, the plates become in this manner neutralized or discharged. The ions, in fact, confer the property of conductivity upon the gas.

Ions can exist in liquids, and can be moved therein by electric forces, as in the case of a gas. The slow motion of the ions in an electrolyte confers on it its conductivity. In recalling these trite facts, we would emphasize the ubiquity of the ion. We might advance yet further. The conductivity of solids is very probably due to the free motion of electrons within them. It is probable that these electrons, the mobility of which is peculiar to conductors, stand in a different relation to the molecules of the substance from electrons concerned with the chemical forces attracting atom to atom. The latter class of electron we shall now consider.

The chemist to-day recognizes that ionization is at the basis of chemical activity, the force of attraction between the positive and the negative ion playing a fundamental part. As we have seen, the loss of an electron converts the neutral atom to a positive ion ; the addition of one converts the neutral atom to the negative ion.

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(4) **Rutherford,** *loc cit.*

It is through the agency of the ion that the light ray, or the γ ray, effects chemical changes. The freeing of the electron is the primary effect. Such electrons—*i.e.* those concerned with the chemical bonding—are termed valency electrons. How important this action is in Nature will be realized when we consider that the metabolism of green plants the world over depends on the photo-electric activity of the sun's rays.

We might fill much space in merely listing the cases of photo-chemical changes which have been studied within recent years. The chemical changes seem in many cases to be brought about by the reduction of one molecule and the oxidation of another. Such actions can progress in solids, liquids, or gases. They may be produced by visible or ultra-violet light, by X rays, by γ rays, or by β rays. They may be sudden when intense radiation acts upon easily changed substances. Or they may take ages to accomplish, as in the case of mineral changes brought about by the ionizing activity of the α rays of radio-active substances acting in the rocks.

(5) On the living cell γ or X rays produce remarkable effects. The study of these effects in plants dates back several years. Schobert, Errera, Molisch, Guilleminot, and others have contributed to it.(6) The rays may retard cell division, and more especially affect the germinating embryo. They may kill such cells. They may also in very feeble doses promote cell division. Gaskell has specially studied the effects of X rays on the embryonic cells of the chick.(7) He found that up to a certain amount of exposure the embryo may make complete recovery from the injurious effects of the rays, but that there is a critical dosage beyond which recovery does not occur and development stops. The effects of ultra-violet light in setting up mitosis in certain cells of the eye are beautifully shown in experiments by E. K. Martin (Proc. Roy. Soc., B85, July, 1912, p. 319). Certain ultra-violet rays—the Schumann rays—are said to be always very destructive in their action on living protoplasm, giving rise to cytolysis and death in the cases of spirogyra, amœba, and other unicellular organisms, in less than one minute. These wave-lengths, which are about half the length of visible rays in the violet, are rapidly absorbed even in air. It has been suggested that destructive organic effects are due to untimely oxidation.

The physician possesses in radiation a subtle means of attacking the mechanism of cell-growth, and one of unlimited power. It is a characteristic feature of true scientific advance that new powers, based on newly-discovered forces, are placed at our disposal. The possibility of physical interference with the atomic linkages of organic structure and its sustaining metabolic processes is a recent conception. The older practice recognised one way only of effecting such interference—by the intervention of chemical actions set up by drugs assimilated through the digestive system. Although we are to-day far from a knowledge giving complete control of radiative effects, I venture to think that these will ultimately be found to be more definable and manageable than medicinal treatment.

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(5) Based on a paper read to the members of the Dublin Clinical Club on March 16, by Prof. J. Joly, F.R.S. Reprinted with abbreviations and some revision from the Scientific Proceedings of the Royal Dublin Society, vol. xiv., No. xxxvii.

(6) "Le Radium," vii., 1910, p. 247.

(7) Gaskell, Proc. Roy. Soc., Ser. B., vol. lxxxiii., February, 1911, p. 305.

Let us consider, so far as we can, what we are doing when we insert into a tumour a needle filled with emanation.

Within the tube the radio-active transformations of the atom are attended by three forms of radiations.

(1) α rays, which are positively electrified helium atoms, and cannot pass the walls of the tube. With these, therefore, we have nothing to do.

(2) Also β rays, or electrons, are sent out. Some of these are so slow as also to be stopped by the thin glass and steel walls surrounding the radio-active substances. But these walls are thin enough, as used in the technique introduced by the Radium Institute of the Royal Dublin Society,(8) to permit a large proportion of them to escape. Their velocity varies over a wide range, some electrons moving at speeds nine-tenths that of light. Their velocities are such as to give, as already stated, both a line and a continuous " spectrum " when sorted out by a magnetic field.

These electrons are known to be the direct agents in effecting ionization. The faster electrons probably penetrate a couple of centimetres in soft tissues, their energy dying out in the creation of ions and secondary γ rays. The latter are re-converted to β radiations, which again take up the work of ionization. Thus the whole of their energy, or the greater part of it, is, probably, ultimately spent in the work of ionization: in other words, on work which is capable of seriously modifying the chemical and molecular processes progressing in the medium.

(3) There emerge, also, from the tube the γ rays of Ra B and Ra C. The latter enormously predominate, most of the rays of Ra B being sufficiently soft to be absorbed in the walls of the tubes. These rays, as we have seen, move with certain definite quanta of energy, or in integrals of a certain quantum in each case: in short, in trains of rays. Wherever they traverse atoms they give rise to β rays. Some of these, taking up the whole energy of a wave-train, move with velocities similar to the most penetrating primary β rays given out by the parent radio-active atoms. This is the inner history of the events leading to the ionisation of the medium according to recent views.

The number of ions which these rays can generate in air has been computed.(9) In reckoning the number of ions two count for one, as each electron separated involves the formation of both a + and a — ion. The numbers given refer, therefore, to pairs of ions.

The quantities of the substances Ra B and Ra C used in the estimates are those which will be in equilibrium with one gram of elemental radium or with one curie of emanation. These substances alone concern the surgeon when he applies radio-active treatment by usage of the emanation. The rays are supposed to act for one second of time.

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(8) Stevenson, *Brit. Med. Jour.*, July 4, 1914, and March 20, 1915.

(9) Moseley and Robinson, *Phil. Mag.*, vol. xxviii., September, 1914.

From β rays of	Ra B	... ...	$0{\cdot}325 \times 10^{15}$
,, β ,,	Ra C	... ...	$0{\cdot}64 \times 10^{15}$
,, γ ,,	Ra B	... ...	$0{\cdot}084 \times 10^{15}$
,, γ ,,	Ra C	... ...	$1{\cdot}134 \times 10^{15}$
	Total	... ...	$2{\cdot}183 \times 10^{15}$

Now it is of interest to estimate what these numbers would represent in the therapeutic use of these radiations in body-tissues, on the assumption that the energy is in a similar degree expended on ionization—an assumption which may approximate to the facts, seeing that the mere state of aggregation—solid, liquid, or gaseous—should not much affect the results. I take the volume of an average cell as 125×10^{-9} cubic centimetres, which is the volume of a cube 1/500 of an inch on the edge.

I shall assume the surgeon inserts the radio-active needles containing the emanation one centimetre apart, and that he has only one millicurie in each needle, the radio-active length of the needle being one centimetre. I shall also assume, as a first approximation, that the radiations are completely absorbed within the boundaries of the tumour being treated.

The number of pairs of ions generated per second by one millicurie will be $2{\cdot}18 \times 10^{12}$. And as the needles are one centimetre apart, we have this number generated per cubic centimetre. In a single cell the number is 272×10^{3} pairs of ions.

In actual practice there may be about five millicuries in each needle. We have then, theoretically, more than 1·3 million pairs of ions generated per cell per second. The assumption that all the rays are absorbed in the tumour is not accurate, and again the numbers given apply to quite unscreened radiation only. The softer β and γ rays suffer absorption in the glass and steel envelopes. This loss applies chiefly to the rays from Ra B. In order to make a safe allowance for these sources of error, as well as for the loss of the most penetrating of the γ rays of Ra C which escape from the tumour, I take 50 per cent. of the calculated number of ions, that is, 136,000 pairs of ions per cell per millicurie per second; or, in the working conditions, 680,000 per cell per second. In exposures measured by hours the numbers rise to thousands of millions: in ten hours to twenty-four thousand millions of pairs of ions per cell.

These figures are instructive, whether they represent entirely effective and useful ionization or not. Even if only a small fraction is usefully expended, they reveal the power of radio-therapeutic methods in controlling or initiating chemical changes within the cell.

The effects of this powerful ionization on the cells of the body have been demonstrated repeatedly by microscopic examination. I would refer more especially to the fine series of photographs obtained by A. Clifford Morson on carcinoma and sarcoma before and after exposure to radiation.(10) After treatment for twenty-four hours with 90 mgrms. of radium the obliteration of structure is far advanced, or even, to all appearance, complete. In the case of healthy cells of the rat, Lazarus-Barlow has shown that considerable exposures may produce no more than temporary disturbance of growth, and that even while treatment is proceeding the cells may become again apparently normal.(11) The important point has frequently been brought out that the healthy cell behaves as a less sensitive system. This, of course, is at the basis of radio-active treatment. It is not improbable that a dosage which will do no more than stimulate mitosis in a healthy cell will suffice to destroy the less stable cancer cell. The latter is, indeed, so unstable towards the ionizing effects of the rays that a very small dose will arrest development, and even cause the destruction of the cell. A tube guaranteed to contain five milligrams of pure radium bromide was several times applied to cases of cancer in this city, the tube being screened with thin sheet-lead and applied externally. It was afterwards found that the tube contained but 0·8 mgrm. of radium element. This was, therefore, a very small dosage. All the results obtained were, however, beneficial. The whole subject is probably in its first stages of investigation in spite of the work which has been done.

Failing the guidance which investigation will assuredly one day give us, it is interesting, and, possibly, important to discuss the cell as a photo-sensitive molecular system, and in so far comparable with another photo-sensitive molecular system, the study of which is less difficult to pursue.(12)

Of all photo-sensitive systems with which we are acquainted the photographic film is at once the most accessible to observation and the best understood; although in this, no more than in any other case, is our knowledge complete, or our views always capable of actual demonstration. We know it to consist of halogenised molecules emulsified in an organic colloid, the relations of salt and colloid being probably complex, and such that they react one upon the other in responding to the photo-electric effect. Certain features in common with the cell will be recognised in this statement. It is, indeed, possible that we might apply it word for word as a general description of the activity of the cell as a photo-sensitive system.

The photograph is an effect of photo-electric activity. This activity, which operates during exposure, generates the latent image. The latent image is afterwards acted on by the developer, and the negative produced.

In this process we start with a halide of silver, loosely combined with the complex molecule of the gelatine, or in a state of solid solution, the instability of the silver halide being increased by its immersion in the gelatine according to principles which have been pointed out by Sir J. J. Thomson, in the case of ordinary solutions in water.(13) We end up with separated metallic silver. The process is, then, one of reduction on the whole. But it is effected in two

(10) Morson, "Archives of the Middlesex Hospital," xxxiii., p. 110.
(11) Lazarus-Barlow, *loc. cit.*, p. 34.
(12) Joly, Proc. Roy. Soc., Ser. B, vol. lxxxviii., 1914.
(13) J. J. Thomson, *Phil. Mag.*, vol. xxxvi., 1893, p. 320.

stages. First, the photo-electric action; then the chemical action of the developer or reducing agent on the latent image.

The view that the process of formation of the latent image is founded in the expulsion of the electron under the photo-electric force is supported by many circumstances.(14) . . .

What may be described as a state of static ionization is set up, the discharged electrons creating negative ions by attachment to the gelatine surrounding the silver-bromide-gelatine systems, and forming an electro-negative region which may be regarded chemically as comparable to an increase in negative ionic concentration.

The developer acting at this stage—*i.e.* when the latent image has been formed—finds the process of reduction facilitated by these conditions. For the developer is essentially a reducing agent, and the latent image represents a temporary release of the positive silver ion from attachment to the chlorine ion, the latter having lost its charge.

The latent image is, in short, one stage in the reduction of the complex silver bromide molecule. But it is a stage reached by physical means, and owes its stable character to the solid nature of the medium in which it is immersed. Nevertheless, it runs down in course of time and disappears; the negative electron gradually being attracted back to the central positive system, and re-combining with the chlorine whence it came. The process of destruction may be accelerated by over-exposure to light, X or γ rays. This is the phenomenon of reversal or solarisation. The probable explanation is that by continued exposure the electrostatic stress set up by electronic segregation accumulates to the point of rupture, and there is a hurried return of the electron to its starting point under the electric stress.

The latent image may also be induced by friction, pressure, or, generally, by mechanical irritation of the film. The action of the mechanical stimulus is probably to induce directly the separation of electrons, *i.e.* to promote the negative ionization. A latent image so formed can be reversed by radiation.

The reversal of the latent image may, in some cases at least, be effected by the infra-red and the heat waves. This might have been anticipated from the theory given above, for we would expect a feeble displacement of the electrons by the long waves, under which effect they would re-combine.

We have now to consider the formation of the latent image by chemical means.

If the latent image is essentially the result of a partial reduction of the silver halide we should expect its creation by reducing agents. The developers and sensitisers, in point of fact, generally create the latent image, and act most effectively when alkaline, *e.g.* pyrogallol, gallic acid, tannin, aqueous solutions of nicotine, and—it is stated(15)—alkaline solutions of lactose and glucose. These substances, acting as developers, must, whatever stages may intervene, ultimately neutralise the charge upon the positive silver ion in the emulsion, setting it free as metallic silver. The effects are probably continuous with those of radiation in creating the latent image. Dilute solution of ammonium hydrate alone will give the latent image. Some substances act as sensitisers, or owe their special efficiency as developers to their active absorption of the halogen.

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(14) Joly, NATURE, vol. lxxii., July 27, 1905, p. 308.

(15) Meldola, "Chemistry of Photography" (Macmillan, 1891), p. 190.

As opposed to the effects of the concentration of the negative hydroxyl ion in alkaline development, the action of the positive hydrogen ion upon the latent image is to inhibit its growth, or reverse it if already formed by light or otherwise. This result is made apparent by introducing a very weak solution of a mineral acid. The oxidation of the reduction product, or the re-halogenisation of the partially reduced silver, may be involved, according to the nature of the acid used. The feature common to all acid intervention is the increased concentration of the positive hydrogen ion.

The photo-sensitive molecular system of the film can exist in different states of sensitiveness, ranging from a highly sensitive to a relatively insensitive state. The behaviour of the "ripened" emulsion of the fast plate (*i.e.* of an emulsion which has been subjected to a process of prolonged heating) is similar in kind to that of the "unripened" emulsion of the slow plate, but in the former all the phenomena are relatively advanced. The latent image is sooner formed under a given exposure, and much more readily reversed. Chemical effects are correspondingly accelerated. The grain of the sensitive or ripened film is much coarser than that of the slow or unripened film.

(To be continued.)

A FEW REMARKS ON THE USE OF INTENSIFYING SCREENS IN RADIOGRAPHIC WORK.

By L. G. Heilbron.

From the X-Ray Institute of the University of Amsterdam (Director, Prof. Wertheim Salomonson).

For several years in the X-ray Institute of the University of Amsterdam, under the direction of Professor Wertheim Salomonson, we have used intensifying screens for most of our radiographic examinations. It may be of interest to relate something of our results, as they seem to be more or less in contradiction with the opinion of several of the leading Roentgenologists. Most of them advocate the use of intensifying screens in combination with X-ray machines of little output, or in the case of movable and contractile organs, or refractory or unruly patients. They only try to shorten the time of exposure as much as possible, but they seem to forget another advantage that may be derived from the use of good screens.

It is only possible to render an enclosed organ visible on the radiographic plate when there is enough difference in its permeability for X rays with respect to the neighbouring organs. Where nature does not give the contrast we are able to make an artificial one, especially in the case of hollow organs. A more direct way of getting contrast on the plate is sometimes given in the use of very low vacuum tubes. When using such tubes it is possible to render separately visible skin, subcutaneous fat, groups of muscles, etc. Other parts of the human body, however, do not allow of an examination with very low tubes ; in these cases such large quantities of X rays would be wanted on the surface of the body to get sufficient X-ray energy on the plate that some danger might arise for the health of the patient. At the same time even the high transformer or the tubes might be damaged. The greatest advantage we have found in the use of intensifying screens lies in the possibility of using much lower tubes than without the use of a screen. At the same time I must lay stress on the fact that the use of soft tubes offers not only an advantage with regard to improving the contrast of the negative, but that they offer the only means of getting perfectly clear negatives. Even with a medium hard tube no clear negatives can be produced. The grain of even a very perfect screen grows visible and mars the beauty and the clearness of the negative.

In a meeting of the Nederlandsche Vereeniging voor Röntgenologie en Electrologie (Dutch Röntgen Ray Society), the writer of this composition could show a great number of negatives of the kidney region, and could observe the surprise of those of the members who make little or no use of intensifying screens for radiographic examination of the kidneys.

In 1912, Belot and Béclère (1) complain that they are not able to get screens which give really satisfactory results ; the older screens were much better.

Haenisch, of Hamburg (2), cautions against the use of intensifying screens in kidney work, as the negatives lose much of their clearness ; his opinion as well as Albers Schönberg's (3) that " in kidney stones they are not to be recommended," may absolutely be rejected by us as not agreeing with our experience. On the contrary, we have found that the use of intensifying screens in radiographic examination of the kidneys constitutes a decided advantage. Even from very lean people we are able to get a sharp defined shadow of the kidney on the plate, and a layer of fat is not strictly wanted to give a perfect contrast between the kidney and the surrounding organs.

Albars Köhler (4) expresses doubt even as to the possibility of getting radiographs of the kidneys in children on account of the want of fat. When using an intensifying screen it is an exception if one is not able to find the shadow of the kidney on the plate.

In France screens are extensively used in kidney work. D'Arectin has probably been one of the first to acknowledge the real improvement afforded by a good screen and to show the excellent work that can be done with it.

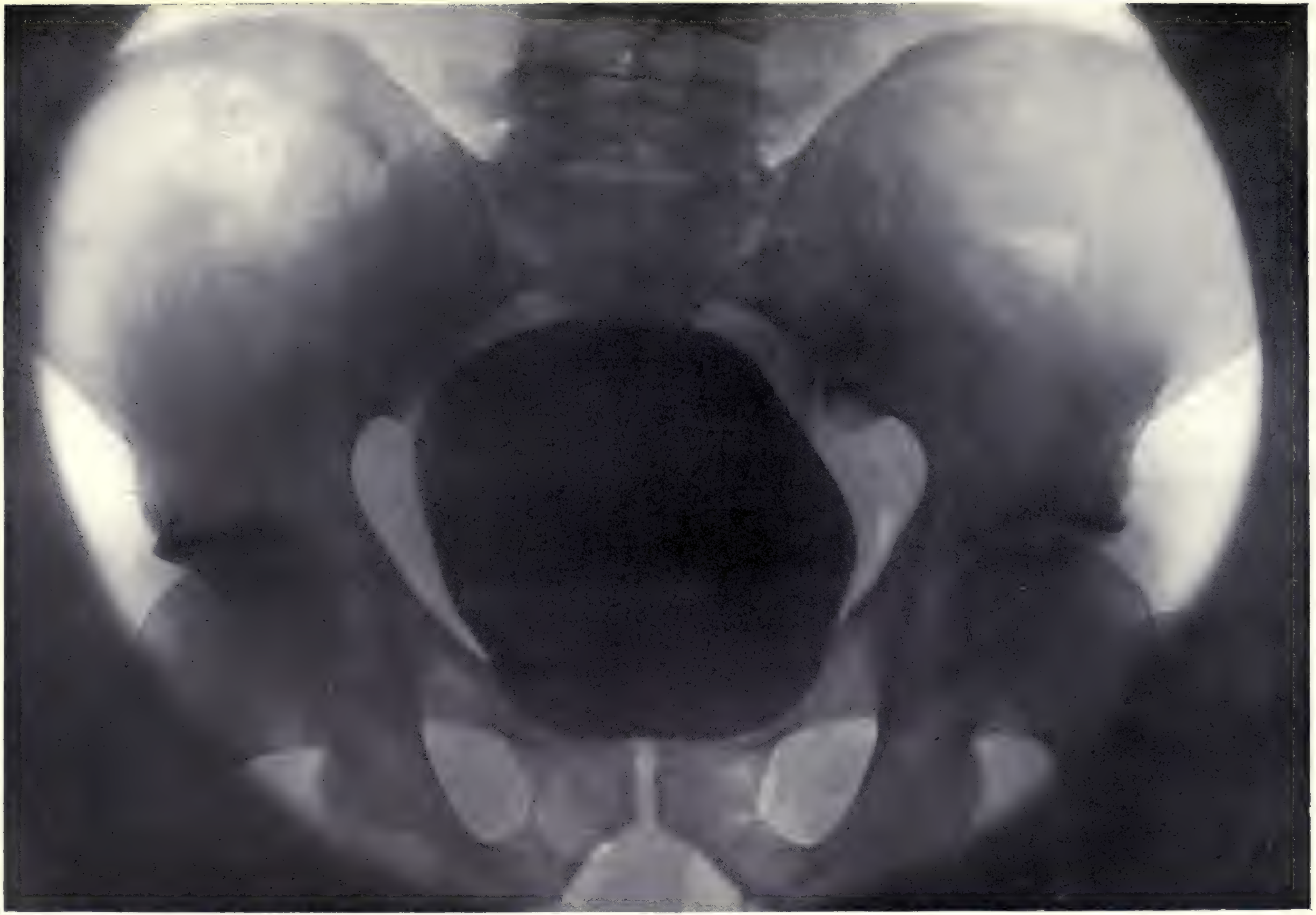
Our own technique is as follows :—The tube is regulated so as to give rays of the required degree of penetration, generally about 5 Benoist. We do not measure the hardness in every case with a direct method, but the deflection of the milliampèremeter is taken as an indicator of the hardness of the rays, the regulating resistance being always adjusted to the same value. This last having been done we know, *e.g.*, that when with our Snook machine a deflection of 14 milliamps is obtained the penetration is about 5 Benoist, with 11 milliamps about 6, with 8 milliamps about 7 Benoist. For kidney work we apply 13-14 milliamps during 12 seconds at a focus-plate distance of 60 cm. We generally use the Gehler Folie in combination with Agfa-Röntgen plates. These are taken out of the plate-holder shortly after exposure and developed in a hydroquinone developer. The time of exposure is slightly reduced with children or with small and lean people; it should be somewhat increased with fleshy plump ones. With the first we lower the vacuum in the tube so as to pass 14 milliamps, or even 14.5, whilst with the last we take care that not more than 11.5 or even 12 milliamps can pass through the tube, the adjustment of the regulating resistance being the same in both cases.

With other screens, *e.g.*, the Radiologic-celluloid screen, we get the same results. The negatives do not show the least trace of grain. The screens are somewhat less delicate to handle, they are washable, but they require a slightly longer (about 20 per cent.) exposure than the Gehler Folie. One should not buy a screen without a careful examination and without having tried it personally.

Agfa plates gave us excellent results, as they yield beautifully clear and yet dense negatives; but probably equal results may be obtained by the use of different brands of plates of English or French manufacturers.

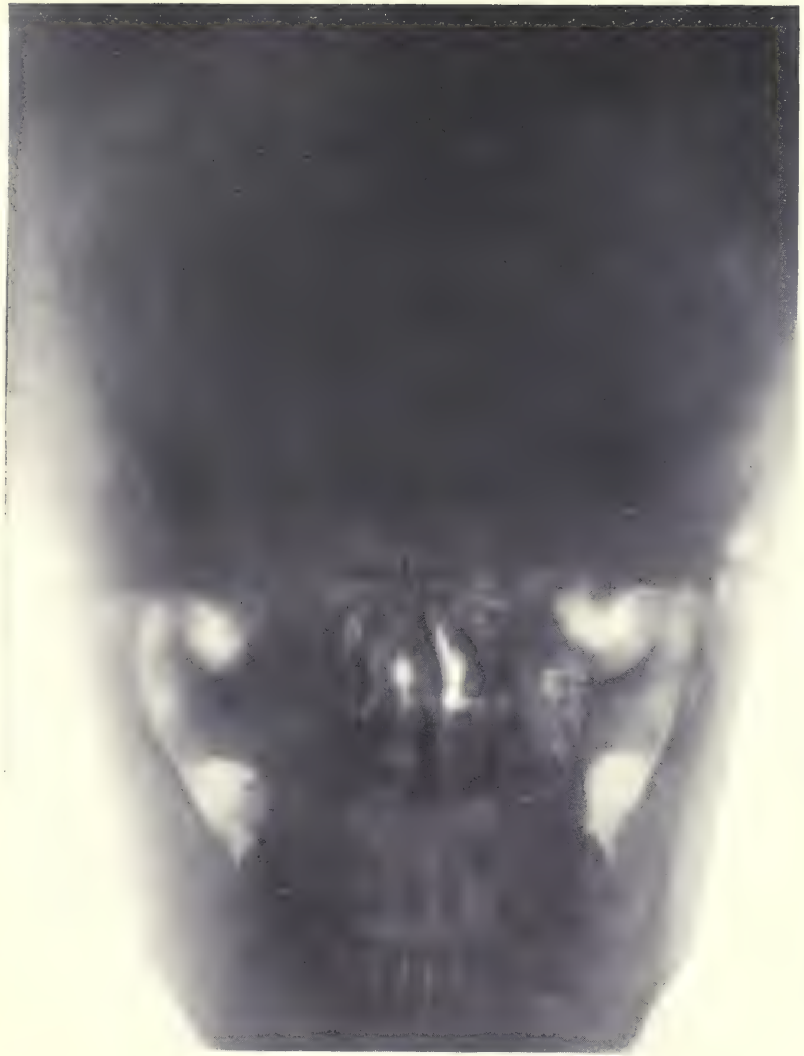
An important factor in kidney work is a reliable compressing apparatus. We prefer the well-known compression girt and loofah cushion, which allows of strong and efficient compression without causing more inconvenience to the patient than is absolutely necessary. The cylinder diaphragm forms part of the tube stand. We prefer this arrangement to the Albers Schönberg compressor diaphragm, which serves at the same time as a diaphragm and tube stand.

The intensifying screen is now everywhere used in all radiographic work connected with the alimentary tract. I do not think that there is any doubt in this respect, but most radiographers are not yet alive to the desirability of its use in the examination of the osseous system. They use it perhaps for radiographs of the spine, and even of the pelvis or the hip or shoulder joint, but they draw the line at the extremities. But there also we can easily get radiographs which can hardly be distinguished from those taken without a screen, as they show nearly the same delicate structure and richness in details as these. For transversal and still more for sagittal radiographs of the head the use of the intensifying screen cannot be too highly praised. For lateral views we may perhaps get as good results without a screen, but I never succeeded in getting a postero-anterior view without a screen comparable with those taken with a screen. For a few years we have regularly used screens as much as possible. Only the hands, feet, and teeth are regularly radiographed without a screen. During these years the life of the tubes in use have remarkably increased; as they are worked with a lower vacuum during

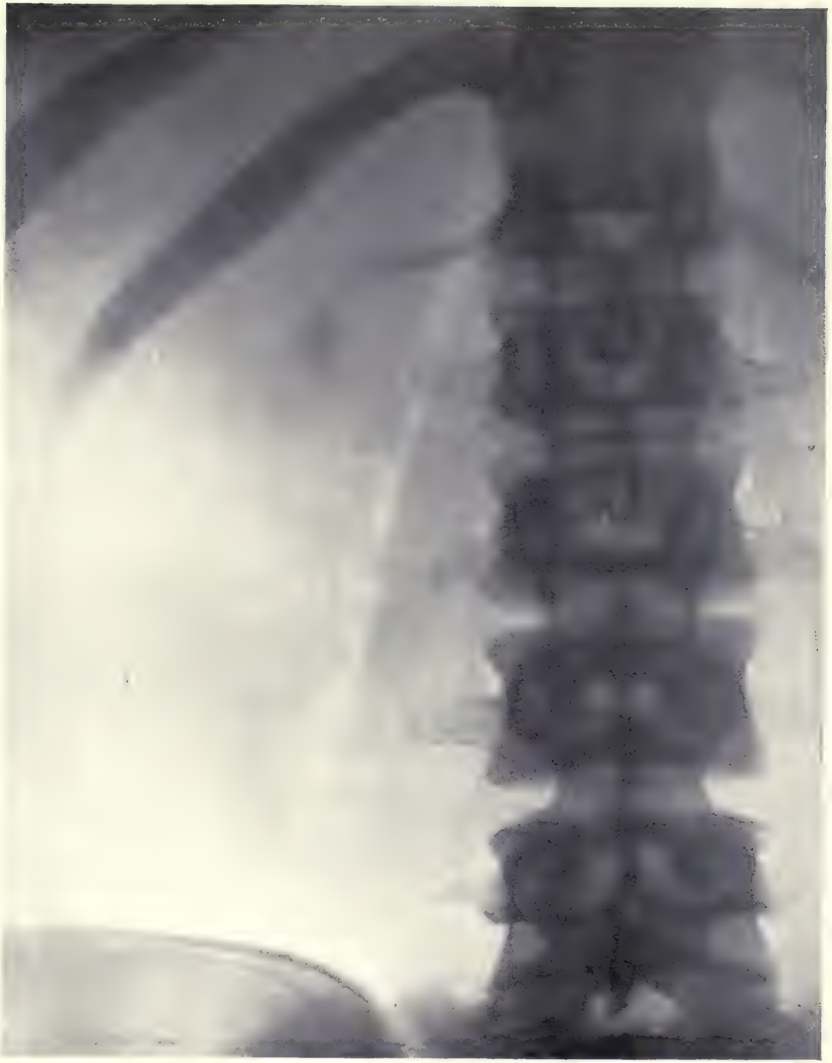


Large Stone in the Bladder. Photographed with intensifying screen.

Plate 19.



Empyema of the Right Highmore Sinus.
Photographed with intensifying screen.



Kidney Stone.
Photographed with intensifying screen.

Plate 20.

a shorter time than before they can last much longer. A good intensifying screen pays itself many times.

(1) Belot and Béclère ; Etude sur la valeur des écrans renforçateurs actuels (Bulletin et Mémoires de la Société de Radiologie Medicale de Paris).

(2) Fedor Haenisch : Die Röntgen untersuchung des unpœlisches Systems Lehman's Med. Ulante. Bd. VII. i. 1914.

(3) Albers Schönberg : The Reinforcing Screen. ARCHIVES OF THE ROENGEN RAY, No. 116, 1910.

(4) Albars Köhler : Lexicon des Genres des Normales, 1910.

ON THE CAUSATION OF WILLIAMS' SIGN IN EARLY PULMONARY TUBERCULOSIS.

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A DIMINUTION in the extent of the inspiratory depression of the diaphragm accompanies many diseases of the lung and pleura, including pulmonary phthisis. This loss of movement in tubercle occurs at an early stage on the affected side, and is known as Williams' sign. It is by no means general.

(1) Its origin has been attributed to a variety of causes ; and it will be expedient, in the first place, to submit each to a brief examination :—

- (*a*) It has been assumed that there is a diminished power of retraction or loss of contractility in the tissues of the implicated lung.
- (*b*) The diaphragm may be intimately connected with pleuritic adhesions which hinder its excursions.
- (*c*) The terminal branches of the vagus may be involved, being unduly exposed to the effects of pressure or strain. A reflex is elicited which inhibits inspiratory movement or stimulates broncho-constricting fibres.
- (*d*) The phrenic nerve may be invested by pleuritic thickenings at the apex of the lung.

(2) *Average position of the Diaphragm.*—In the erect posture the highest point of the arch *in front* lies near the upper border of the 5th right and lower border of the 5th left rib ; in recumbency the position is slightly higher, *viz.*, the lower border of the 4th right and upper border of the 5th left rib. *Behind*, on standing, the level is near the lower border of the 9th right aud lower border of the 10th left rib : in the horizontal position, the lower border of the 8th right and lower border of the 9th left rib. In quiet normal breathing the amount of movement is practically half an inch : in deep inspiration about two inches, being rather more on the left side in both conditions.

(3) A reduction in the power of shortening, after extension, of the elastic

fibre, or a general condition of atony in the unstriped muscle of the bronchioles will be followed by an increased volume of the lung. The force of diaphragmatic contraction, which acts in opposition to that of the elastic tissue, will be less restrained. On relaxation, moreover, the activity of the elasticity which apparently assists in the preservation of the convex outline of the diaphragm, being diminished, the height of the latter should be decreased. The neutral position will be depressed, and during quiet breathing the excursions will be deficient. But there is no such general downward displacement of the diaphragm ; on the contrary it may, and often is, somewhat higher during the pause than in the normal.

(4) Diaphragmatic pleurisy manifests itself either as a marked prominence in the curve during inspiration, or as a series of small irregularities in its contour. But in cases where Williams' sign is marked the shadow of the diaphragm is often perfectly smooth and regular.

(5) The vagus is a nerve endowed with great possibilities. The area of its distribution is extensive, and it is the motor (cranial autonomic) as well as the sensory nerve of the lung and visceral pleura. It transmits from afferent end-organs—the nature of which is still unknown—inspiratory and expiratory impressions to the medullary respiratory centre. It is possible that the inspiratory inhibiting impulses differ from the expiratory. When the central stump of the vagus is excited with *weak* stimuli, inspiratory movements are inhibited partially or completely, producing either small movements, or—in a condition of narcosis—complete cessation of respiration with the thorax in a state of passive expiration (1). It has also been suggested that the nerve-endings of the vagus may become hyperæsthetic in inflammatory conditions like pneumonia (2), and produce rapid breathing by affecting both halves of the respiratory centre. Where small unilateral lesions exist, a similar condition of hyperæsthesia of the terminal fibres in the pleura or lung may arise, producing a greater reaction during the inspiratory dilatation of alveoli in the hilum or the apex : or vagal branches caught in diseased and enlarged glands within the hilum, along the extra-pulmonary bronchi and the trachea, may be subjected to increased pressure or tension towards the end of inspiration. The vagus also contains broncho-constricting fibres. The broncho-dilating fibres are supplied by the sympathetic (dorso-lumbar autonomic). Afferent impulses proceeding from the nasal mucosa produce reflex broncho-constricting effects. In the same manner irritation may be transmitted from sensory areas of the lung and pleura. It is therefore legitimate to believe that excitation of afferent vagal branches may induce, during inspiration, a premature reciprocal expiratory reflex, with cessation of the inspiratory act before its full completion.

(6) Paralysis or injury of the phrenic nerve is followed by a paradoxical diaphragmatic movement, quite unlike the one under consideration. But the phrenic also contains sensory fibres ; and one naturally regards these as suitable for the conveyance of centripetal impulses of an expiratory nature. But the effects of stimulation of the roots of the nerve—rise of blood pressure, and increased rate and depth of the respiratory movements—differ in no wise

from those produced by excitation of any afferent nerve. Occasionally, as in all sensory nerves, an inspiration in progress at the moment may be arrested; but careful experimentation has failed to demonstrate the production of an expiratory reflex (3).

(7) The view has been expressed that the elasticity of the lung plays but a passive part during the expiratory phase, and that the upper portion of the rectus abdominis can be felt to harden during this period (4). When a healthy individual is breathing quietly and deeply, the extent of the diaphragmatic excursion may be estimated on the screen. If now, after a long pause following expiration, both mouth and nostrils are closed, and an attempt be made to inspire, the halves of the diaphragm move scarcely at all or tend to move in the reverse direction (paradoxical movement). There is an inhibition or relaxation of the diaphragm due, it has been affirmed, to the production of a diminished intrathoracic pressure. As a matter of fact, the latter is produced by the contraction of the inspiratory muscles themselves, and is the effect not the cause. On further examination it will be noticed, first, that the sternomastoids, scaleni, and intercostals harden, and the muscles closing the glottis come into play: secondly, the auxiliary muscles of expiration commence to contract, and, so far as can be felt, *at the same period of time.* These are the recti, obliqui, and possibly the inner intercostals (5). Both sets continue to contract with the perseverance of inspiratory effort. The increased resistance to dilatation apparently stimulates muscle-sense fibres, which transmit impulses to the centre, and incidentally demonstrate the existence, as well, of *inspiratory* fibres, since the time is too short for the production of increased pressure of carbon dioxide in the alveolar air, and for the transference by the blood to the medulla. The impulses, in this case, must be conveyed by the intercostal nerves. It is perhaps an error to assume that the expiratory muscles are under all circumstances very readily exhausted, since the recti and obliqui, at least, always pass into a state of tonic activity whenever the erect posture is assumed and maintained. Moreover, in cases of unilateral extensive pleuritic adhesions hypertrophy of the abdominal muscles on the same side is occasionally observed. These facts may assist in the explanation of several signs of incipient phthisis, and of the behaviour of the diaphragm in certain types of pneumo-thorax.

(8) In the peribronchial and hilum-phthisis of children there may often be observed, towards the end of inspiration, an apparent retraction—really an incomplete expansion—of the lung on the diseased side. It is most distinct in the two upper interspaces near the sternum and has been termed the *dimpling* of the hilum. At the same time the scaleni and sternomastoid of the same, incidentally on both sides, may, at times, be seen to contract. Simultaneously, with care, a unilateral hardening of the rectus and obliquus externus may be perceived. This sign may be employed as a test for the presence of the determination of incomplete expansion of the lung. A sudden rigidity of the intercostals may also occur (Pottenger's sign of early phthisis). In conditions of incomplete pulmonary dilatation there appears to be a struggle between

opposing muscular groups—the sternomastoid, scalene, and the diaphragm on the one hand, with the recti and obliqui, on the other.

(9) In hilum-phthisis some impairment of expansion generally exists in the terminal areas supplied by the three chief upper bronchi. These should correspond with the inner and outer ends of the superior interspaces anteriorly, and to the apex of the lower lobe behind, near the spine of the scapula. In ordinary and in stereoscopic radiograms we have been able to trace conspicuous linear shadows to these three areas (7). In addition to venous and lymphatic stasis, induced by the pressure of enlarged glands (often the tracheo-bronchial group) on vessels at the root of the lung, there may be a condition of partial atelectasis in these situations from the incidence of pleuritic adhesions or from pressure on the bronchial wall. Before the absolute termination of the inspiratory movement, when the limit of expansion is prematurely reached, the auxiliary inspiratory muscles are called into activity, but their contraction may be overcome for a time by the accessory expiratory muscles, since the inspiratory expansion is now on the wane and rapidly approaching its normal conclusion. In other words, if mechanical conditions forbid further dilatation, the expiratory muscles predominate. The resistance of the chest to further expansion probably excites end-organs situated either within the visceral and parietal pleura, or in the tendinous insertions of the inspiratory muscles, the effect of which leads to reflex contraction of the recti, obliqui and others. Moreover, a very small difference of pressure within and without the lungs renders inspiration an impossibility (8). Dr. Steuart, late Chief Assistant in the X-ray department at St. Bartholomew's, found, in some cases, that, if the breath be held after a deep expiration, the movement of the diaphragm in the succeeding inspiration was apparently normal (9). The explanation seems to be that during the longer pause the blood within the centre itself becomes increasingly loaded with carbon dioxide, so that the next inspiratory discharge becomes excessive and may overcome the expiratory reflex which curtails the diaphragmatic movement. If the experiment fails, a real mechanical hindrance to full dilatation is present.

(10) It has been observed that when the locus of disease is situated posteriorly, the diminished excursion is more evident in the dorsal half of the arch (10). The spinal part of the diaphragm is here more affected than the sterno-costal. The muscles which oppose the crural fibres may be the serratus posticus inferior and the quadratus lumborum.

(11) The principal function of the pulmonary vagus appears to be the regulation of the expenditure of muscular effort on the part of the respiratory centre during the two phases of inspiration and expiration, and particularly in the former (11). Injury to the lung which might follow excessive inspiratory dilatation is prevented by afferent expiratory impulses which arise either from the end-organs of muscular sense situated near the tendinous insertions of muscle-fibres (inter-costal nerve), within the bronchial muscles and infundibula (vagus), or in the visceral (vagus) or parietal pleura (inter-costal nerve). Inspiratory vagal impulses are not normally in evidence, and

there is consequently a *pause* after expiration is finished : the succeeding inspiration being produced by the increasing pressure of carbon dioxide in the alveolar air, the effect of which is transmitted through the blood, and stimulates the respiratory centre itself.

(12) It has been shown how inspiration may be inhibited by impressions starting in the pleura and in pulmonary areas beyond the terminations of the bronchioles; and later, when adhesions have formed, also, from the sensory end-organs in the tendons of the inspiratory muscles. This inhibition is generally the result of contraction of expiratory muscles, and its degree will depend upon the intensity of the reciprocal reflex. The movement is often jerky, rhythmic or stammering—a variation which may be owing to the conflict of antagonistic impulses with alternating advantage, and producing the modification called wavy breathing (respiration saccadée). At other times it is conceivable that the discrepancies in the diaphragmatic movement may be due to partial arrest induced by irritation of vagal and other afferent fibres, without the elicitation of a proper expiratory reflex (paragraph 6). On the other hand there are cases of undoubted early phthisis which do not exhibit a trace of William's sign.

It is possible, therefore, to discriminate at least three groups. In the first, the afferent nerves, those of the pleura in particular, escape, and the diaphragmatic movements are normal ; in the second, the contractions are jerky and erratic, and perhaps not much curtailed. This may be due to simple afferent inhibition, accompanied by a spasmodic, incomplete, and irregular reciprocal reflex. In the third, the latter is well established and the activity of the recti and obliqui is easily discernible. The issue is then a reduction in the duration and amplitude of the inspiratory wave, with a definite measure of protection and rest for diseased areas of the lung.

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RECENT STUDIES IN THE DYNAMICS OF LIVING MATTER.

In the issue of *Nature*, July 29th, 1915, there appears an interesting review of some of Prof. Loeb's recent investigations by Professor D'Arcy W. Thompson, from which we quote *in extenso*:—

"There is no falling off in the stream of work which comes from Prof. Jacques Loeb's laboratory in the Rockefeller Institute, from which we have now before us some ten or a dozen papers, mostly by Prof. Loeb himself, all published since the beginning of last year. They deal with various subjects in that field of comparative physiology, or dynamical biology, which Loeb has so diligently reaped as well as sown. Most of them are concerned with one or other of three topics, the phenomenon of heliotropism, the inexhaustible problem of growth, and, lastly, the conditions which determine or which prevent the entrance of the spermatozoon into the egg.

"In Prof. Loeb's book, which bears the title set at the head of this short article, there is a well-known chapter on heliotropism, that is to say on the tendency of plants to turn towards the light, and on other kindred phenomena manifested both in plants and animals; for the polypes of a hydroid colony such as Eudendrium, or the tube-dwelling worms such as Serpula or Spirographis, also bend towards the light, and if they be illuminated by a single beam they grow steadily in the direction of its rays. It is characteristic of the plant (or rather of the green plant) that it represents a peculiar type of machine which is capable of turning radiant energy into chemical energy, and so ultimately into mechanical work; and in the case of the plant, 'the permanency of this kind of machine is guaranteed by the presence of an automatic arrangement, whereby their stems turn towards the light.' So Loeb is inclined to read into this phenomenon what we might call a modified teleology, such indeed as, in one form or another, refuses to be kept out even of our most modern biological speculations.

"In the chapter already alluded to, published some nine years ago, our knowledge was said to be very scanty as to the relative heliotropic efficiency of the various parts of the spectrum, little more being known than that the more refractive rays, the green, the blue, and the violet, were more effective than the yellow and the red. 'There exists thus, apparently,' said Prof. Loeb, 'a division of labour, the longer light-waves accelerating assimilation, and the shorter waves accelerating heliotropism;'—just (we might say) as there is obviously a 'division of labour' between the rays which illuminate and those which warm us.

"Two of Prof. Loeb's recent papers (by Dr. H. Wasteneys and himself) (Pr. Nat. Acad. of Science, January, 1915, and *Science*, February 26, 1915) are devoted to the question of the identity of heliotropism in plants and animals, and thereby to an inquiry into the particular wave-lengths of light to which, in one case or another, they are most sensitive. Instead of exposing the organisms to the solar spectrum itself, as had been done in earlier and simpler experiments, the writers (using a carbon arc spectrum) allowed the light from particular portions of it to pass through narrow slits, and then reflected it in a monochromatic beam upon the subject of their experiments. They soon arrived at the simple but very remarkable result that there are two particular regions of the spectrum the rays of which are especially effective in causing organisms to turn, or to congregate, towards them; these regions lie (1) in the blue, in the neighbourhood of a wave-length of 477 $\mu\mu$, and (2) in the yellowish-green, in the region of $\lambda = 534$ $\mu\mu$; and these two wave-lengths affect different organisms, with no very evident relation to the nature of these latter. Thus the blue rays (of 477 $\mu\mu$) attract the infusorian Euglena, the hydroid Eudendrium, and the seedlings of oats; while the yellowish green rays (of 534 $\mu\mu$) in turn affect the protozoon Chlamydomonas, the little water-flea Daphnia, and the larvæ of barnacles.

"These facts add a quality of precision to many older and vaguer observations, for instance, to Paul Bert's discovery (in 1869) that Daphnia swims towards the light in all parts of the visible spectrum, but most rapidly in the yellow or the green. The particular wave-length of 534 $\mu\mu$ is especially remarkable, because it coincides with a determination by Trendelenberg that the visual purple of the rabbit's eye (which is not affected by red and very little by yellow light) is bleached most rapidly by light the wave-length of which is 536 $\mu\mu$. It would seem, according to Loeb, that among the lower organisms we have to deal with two separate photo-sensitive substances, which determine their heliotropic reactions; that these are distributed without regard to the systematic boundaries, even between plants and animals; and that one of the two, occurring even among very lowly organisms, has characters similar to, and is perhaps identical with, the visual purple of the highest type of eye.

"In another paper (*Science*, November 6, 1914), still dealing with the effects of light, Prof. Loeb relates some remarkable observations on the action of ultra-violet rays upon unfertilised eggs, adding by these new experiments a curious detail to the many facts regarding artificial fertilisation, by chemical or physical means, which we associate with his name as their prime discoverer. On the ground that ultra-violet rays are known to have a sterilising effect, that is to say to be capable agents in the destruction of cell-life, and that, according to Loeb's own experiments, the very substances which induce 'cytolysis' in the living cell are also capable (under proper conditions) of producing artificial parthenogenesis, Loeb thought it likely that these rays would also prove to be effective stimuli, under the appropriate conditions, of parthenogenetic development. He exposed the unfertilised eggs of a sea-urchin for ten minutes to the light of a quartz mercury arc lamp, and found that the majority of the eggs formed 'fertilisation membranes'; when kept cool they further proceeded to segment, but ere long perished; an addition of hypertonic sea-water, however, enabled them to develop into larvæ, though few advanced beyond the gastrula stage. It was remarkable that a cover-glass, 0·1 mm. thick, was sufficient to prevent all action on the part of the light, a fact which bears closely on the wave-length of the rays which produced the action.

"The discovery here mentioned is certainly interesting as a specific case of the effect of radiant energy on living protoplasm; but its precise degree of interest turns largely on the importance which we may attach to the formation of a surface-membrane as an essential preliminary to the development of the egg. According to Loeb this phenomenon is of supreme importance; for the question why an unfertilised egg cannot grow, and why a fertilised egg can grow and divide, depends, according to him, entirely on the condition of the surface layer of the egg; the nature of this cortical layer determines whether the egg be in an active or a passive phase, and the essential factor is a change in the rate of oxidation, to which the condition of the cortical layer directly leads. 'The forces which induce the egg to develop are, therefore, localised *at the surface of the cell.*' This is a somewhat hard saying, but in Prof. Loeb's hands it leads to many suggestive and stimulating reflections. The whole subject is discussed in his book on 'Artificial Parthenogenesis, etc.' (1913), and in a paper now before us, on the Stimulation of Growth (*Science*, May 14, 1915).

It is of interest in connection with this review of Loeb's recent work to notice the extraordinary variations in the response which the lowest forms of animal life exhibit to various types of radiation. We may notice in particular that the infusorian Euglena is especially responsive to blue rays of wave-length 477 $\mu\mu$. As the result of experiments performed in 1904, Miss Willcock found that motile forms of Euglena were quite insensitive to a beam of beta rays of considerable intensity. Again, it was found by Loeb that the small water-flea Daphnia was more affected by rays of wave-length 534 $\mu\mu$ than when submitted to the radiation from other parts of the spectrum. In 1903 Bohn found that this organism survived exposure to the beta rays of radium about six times as long as Asellus when exposed under similar conditions.

These studies appear to be but one aspect of the whole question of the response of living cells to radiation. The correlation of sensitiveness on the part of organisms to the particular types of radiation, whether in the visible spectrum or the region of X rays or gamma rays, with their cytological characteristics, would appear to be a valuable contribution to our knowledge. It is not unlikely that such information would contribute in no small degree to a better understanding of what is termed "reaction to the rays."

REPORT OF SOCIETY.

ROENTGENOLOGICAL ASPECT OF INTESTINAL STASIS.

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[Read before the Baltimore Medical Society, November, 1914.]

INTRODUCTORY REMARKS.

As one of the means of diagnosing stasis in the alimentary tract the Roentgen Ray has been given the foremost place; other methods are valuable, and where simply the time for passage of the meal through the canal is desired, the administration of any bland inert material may be used, the significance being the time of appearance in the stool. This, of course, does not throw any light upon the usual surgical causes of stasis. This leads us to divide stasis into those cases which are due to simple delay without obstruction and those due to mechanical obstruction in some part of the alimentary tube. The first group suffer more from true auto-intoxication, while the second group seem to have symptoms which are due to mechanical obstruction.

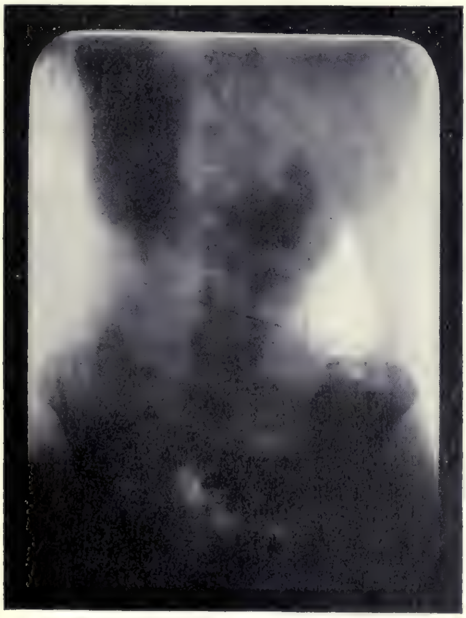

FIG. 1—6 hours: Ileocæcal spasm.

WHAT IS STASIS?

Lane's definition: Such an abnormal delay in the passage of the intestinal contents through a portion or portions of the gastro-intestinal tract as results in the absorption into the circulation of a greater quantity of toxic or poisonous materials than can be treated effectually by the organs, whose function it is to correct them into products as innoxious as possible to the tissues of the body.

CAUSES OF STASIS.

Stasis may be caused by existing visceroptosis, intestinal kinks, adhesions and dilatation or enlargement of various portions of the alimentary tube; the result of congenital malformations, which produce a delay in intestinal prochoresis and localized infection of the mucous membrane, producing perityphlitis.

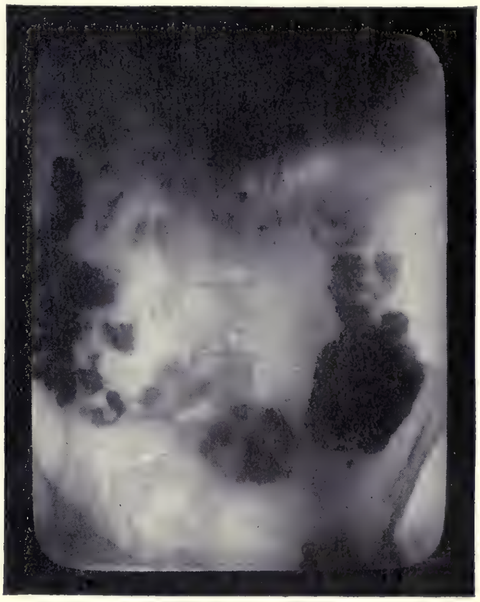

FIG. 2—10 hours: Gastric retention and intestinal delay due to ileal kink.

ROENTGENOLOGICAL FINDINGS IN STASIS.

Stasis, when due to mechanical obstruction, shows increase of the normal time for the passage of the opaque meal through the intestinal tract; retention at point of obstruction and at the various sphincters from below upward; dilatation on the oral side of the obstruction; displacement of portions of the neighbouring hollow viscus when the cause of the obstruction is adhesive bands. The conditions producing stasis not associated with mechanical obstruction are incompetent ileocæcal valve allowing a return influx of the cæcal contents into the ileum; spasm of the ileocæcal valve preventing contents of the ileum from passing into the cæcum, and a sagging of the transverse colon causing sharp angulation of the splenic flexure; dilatation of the colon either congenital or acquired; redundancy of the pelvic colon with lengthening and atony.

OPINION IN FAVOUR OF AND OPPOSED TO THE STASIS THEORY AS A CAUSE OF AUTO-INTOXICATION.

Lane stands foremost among those who attribute auto-intoxication to stasis, and who makes most of his diagnoses by the Roentgen method, and who practises the most radical surgical procedures to improve drainage. He has many followers. Jordon thinks that a sagging transverse colon by causing a sharp angulation of the splenic flexure causes stasis.

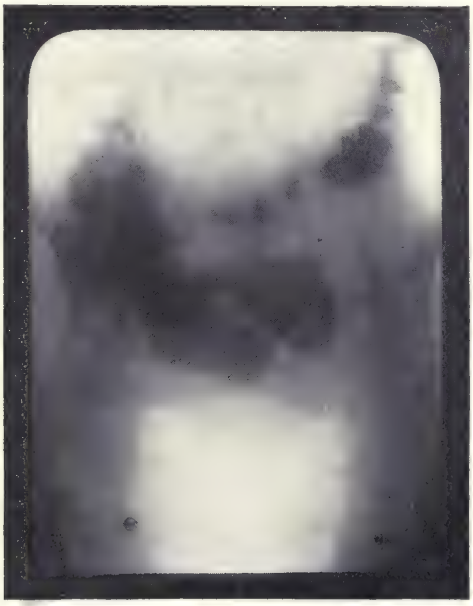

FIG. 3—12 hours: Dilated terminal ileum due to mechanical obstruction at the terminal ileum.

It is frequent that in these cases which have toxic symptoms the progress of the meal is usually normal up to the splenic flexure (Figure 5), and here it remains until moved on by some artificial means. The most likely explanation is Jordon's idea as I have frequently noted in my own work.

Einhorn gives credit to Glenard for the angulation theory of stasis and claims that Bouchard and Combe advanced the theory of stasis as a cause for auto-intoxication. Einhorn thinks that unless there is a real mechanical obstruction or a substantial organic lesion interfering with the intestinal current, a temporary delay or stasis does not mean much and is often seen in insufficient nutrition. The unobstructive cause of stasis is constipation, which not always causes auto-intoxication, for occasionally a patient may not have any bowel movement for several days and present no abnormal symptoms.

Bassler disagrees with Lane's theory and thinks "that if one would examine bacteriologically a number of stools of these persons and compare them with normal individuals, significance would be noted. The primary cause of the conditions is mostly a bacterial matter, and it is the food bacterial products that eventually bring about stasis, which surgeons are endeavouring to remove by drainage, but which cannot be done successfully because the infections commonly continue after operation." He thinks "that the Roentgen Ray method of diagnosing Intestinal Stasis, while valuable and the best we have, is liable to fallacious conclusions." The misfortune was when medical men utilized the Roentgen Ray in connection with diagnosis in the abdomen they did not engage as their first work the normal individual. He is surprised to find the number of normal individuals who present

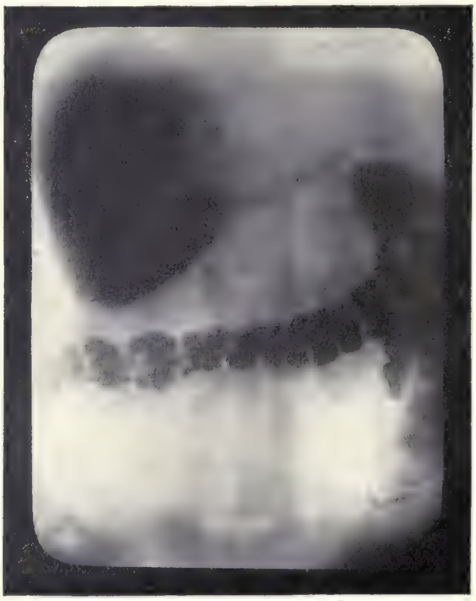

FIG. 4—18 hours: Kinked appendix, adherent, causing partial gastric delay.

all the Roentgen Ray signs that have been held so important for this diagnosis, and reiterates that we must be slow and conservative in drawing definite conclusions from Roentgen plates alone.

PERSONAL OBSERVATIONS IN 260 X-RAY EXAMINATIONS.

Eighty-eight instances of intestinal stasis were noted, of which 73 were ileal stasis and 16 colonic stasis. Sixty-six and six-tenth per cent. were explained by the existence of the following conditions: Gastroptosis and enteroptosis, 6.7 per cent.; post-operative adhesions, 6.8 per cent.; incompetent ileocæcal valve, 2.8 per cent.; chronic appendicitis, 2.5 per cent.; malignant disease of the stomach and intestines, 2.5 per cent.; gastric and duodenal ulcer, 1.8 per cent.; giant colon, 1.7 per cent. Twenty-seven of these patients who presented stasis were unexplained and were found associated with pulmonary tuberculosis, typhoid fever, nephritis, arterio-sclerosis and neurasthenia. These unexplained cases presented more symptoms that might be attributed to auto-intoxication than the purely mechanical ones.

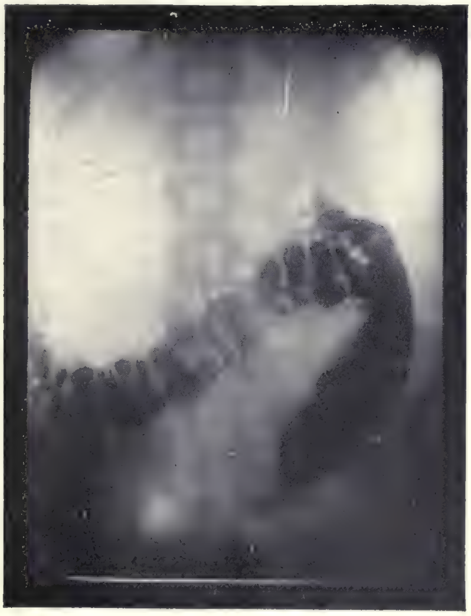

FIG. 5—50 hours: Delay at the splenic flexure. ileal stasis, angulation at the heptic flexure.

METHOD OF X-RAY DIAGNOSIS.

It is conceded by Roentgenologists that both fluoroscopy and radiography are essential; that a complete gastro-intestinal examination is necessary, and that for examination of the large bowel one should follow the meal from above downward, as well as by means of an opaque enema.

The opaque meal is seen in the duodenum within one-half hour of its ingestion and collects after four hours in the ileum and cæcum. Within six hours there is still a trace in the ileum, while nine hours is the time allowed for the normal ileum to empty itself. The reason for this delay in the terminal ileum is the physiological contraction of the ileocæcal valve. Pathological conditions that may cause a delay in the meal reaching the terminal ileum are bands of adhesions, tumours within or without, displacements and ptosis.

In studying emptying time of the ileum the condition of the stomach must be taken into consideration, since any delay in the evacuation of the stomach may prevent the chyme reaching the lower ileum. Ptosis of the small intestines may cause a moderate delay, but it is not an etiological factor in production of chronic constipation. Delayed entrance of the chyme into the cæcum may be due to spasm (Figure 1) or incompetency of the ileocæcal valve and adhesions generally termed Lane's Kinks (Figure 2 & 4). Dilatation of the terminal ileum (Figure 3) is significant of obstruction

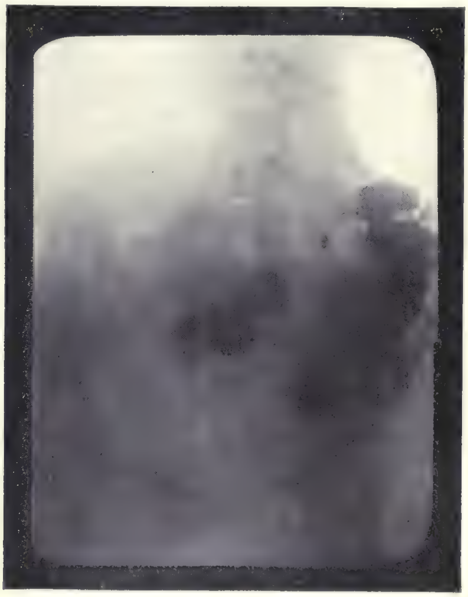

FIG. 6—24 hours: Perityphlitis. scybalous masses in the tranverse colon, colonic stasis.

and demands surgical intervention. The delay may exist from nine to 72 hours.

The cæcum and ascending colon retain the chyme for a longer period than any other portion of the large intestine, and consequently allows much greater opportunity for bacterial action, and if dilated from constipation is the most usual site for manufacturing toxins. When associated with ptosis of the hepatic flexure and adhesions the term perityphlitis (Figure 6) is used. Tuberculosis of this area is a frequent occurrence and is usually recognized as stenosis. Constipation has been divided into hypokinetic and dyskinetic forms and dyschesia. The first is due to lack of muscular tone, the second to antiperistalsis, and the last to delay in evacuation of the rectum. The average time for the opaque meal to fill the colon is 24 hours, and normally the cæcum is clear of the bismuth meal after 48 hours, although frequently it remains in this locality from 60 to 105 hours. This delay is termed stasis.

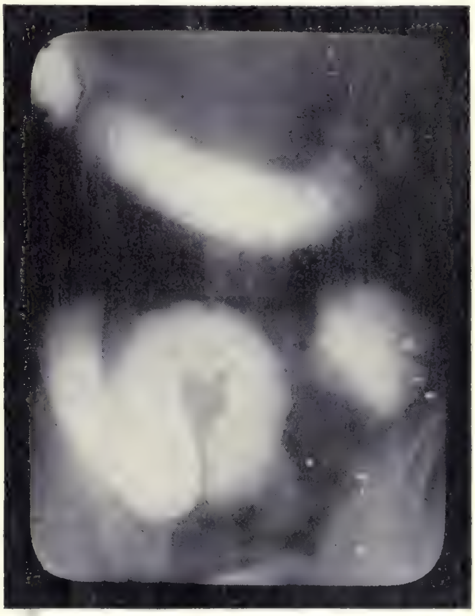

FIG. 7—Colon enema: Redundant sigmoid, dilated colon due to congenitally long mesentery.

The same principle that applies to obstruction in the small intestine is seen here, that when the progress of the meal is delayed, there is dilatation on the oral side with appearance of angulations, constrictions and evidences of growths at the point of obstruction. It is customary to verify these findings by fluoroscopy, when the opaque enema is seen to stop, gradually dilate the intestine on the anal side of the obstruction. In the case of simple angulation the bowel is seen to straighten out like a kinked hose, the meal continuing its progress until it reaches the cæcum. The usual time for the passage of the enema is from four to five minutes, occasionally the period may be less or greater. The former can best be detected accurately by fluoroscopy accompanied by careful palpation. The latter may be determined by plates taken serially.

In cases of constipation the opaque enema is used after thorough cleansing of large bowel and the most usual appearance is dilatation with elongation (Figure 7). I am inclined to believe that these enormous colons are originally of congenital origin, the existence of long mesenteries, which are seen in certain types of individuals, occurring in families. The dyschesia is apparent in a dilated rectal ampullæ. This is more apparent when the opaque enema is used but by the occurrence of scybalous masses (Figure 6) when examination is made by administration of meal by mouth. The plates made by the two methods are so different in appearance that one can tell at a glance when the enema has been used. The difference in the two appearances being that haustral segmentation is more marked when the meal has been given by mouth than when the enema has been used. One quart is usually sufficient to outline the entire colon and can be administered in safety, provided the preliminary cleansing of the colon has been executed.

NORMAL PERISTALSIS.

A word about the normal colonic peristalsis. It has been noted by the Roentgen study of the motor phenomena that we have a regular peristaltic movement, a greater peristaltic movement, antiperistalsis and stormlike movements involving a whole section of the colon. The first is dependent upon the action of circular muscle fibre and acts over a greater area and presents a mixing movement; the greater is more wavelike and causes a marked displacement of feces. Antiperistalsis is known to exist normally and may account for some peculiarities often seen. The stormlike movements occur just before or during defecation and are influenced by the ingestion of food, and are apparent during X-ray examination by the disappearance of segmentation and a remaining linear shadow behind the progress of the contents. As the motion subsides the segmentation reappears. These appearances are seen best following bismuth meal when studying functional disturbances, the bismuth enema being more adapted to discovering organic obstruction.

CONCLUSIONS.

The conclusions drawn from Roentgen observations should be carefully verified and modified in certain instances by recognizing the numerous idiosyncrasies of our patients, nervous phenomena being apt to lead us astray. What has been said of the changes associated with stasis may be summarized as follows: That the frequent cause of delay is obstruction, and when persistent demands conservative surgical interference. That stasis occurs frequently associated with other organic disease, and before symptoms are attributed to stasis these other conditions should be eliminated. The final disposition of the case should not rest entirely on the X-ray examination. When peculiar conditions are noted, it being wiser to use this information as confirmatory. With the standardization of Roentgen evidence, the method is becoming indispensable.

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NEW INSTRUMENTS.

A DESCRIPTION OF TWO NEW INSTRUMENTS.

By Francis Hernaman-Johnson, M.D.,
Captain (tempy), R.A.M.C.; Consulting Radiologist to Military Hospitals in Aldershot Command.

I.—Head Fluoroscope.

Some metallic fragments which it is necessary to remove are either so minute, or so deeply embedded in unstable structures, that no system of skin marking can of itself be relied on as a sufficient guide during operation. An enormously swollen scrotum, from which minute shell splinters have to be extracted, is a case in point.

The only place where such operations can be carried out with the certainty of success is on the X-ray couch. An ordinary fluorescent screen, the back of which is protected by a sterile towel, can, of course, be used; but it is at best a clumsy device.

About three years ago Wullyamoz published in The Archives of the Roentgen Ray a description of a "Forehead Fluoroscope" which could be strapped on to the head of the observer.

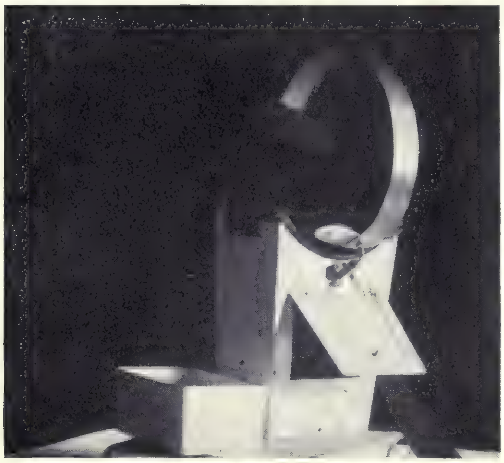
I have had made for use at the Cambridge Hospital, Aldershot, what I believe to be an improved form of the above instrument. It is shown in the accompanying photograph. The modifications which I have introduced are three in number.

(1) The instrument is constructed of aluminium, and a detachable cover of this material is provided for the end containing the screen. This is sterilized by boiling, and affixed to the fluoroscope after the latter has been bound on to the surgeon's head. It is thus quite safe for him to bend down until the lower surface of the cover is almost in contact with the wound; for if it touches the latter accidentally no harm is done.

(2) As the apparatus is generally used where very small fragments are concerned, lenses magnifying 3-4 diameters are placed

inside the instrument, and, to avoid eye strain, prisms with base inwards are combined with the *plus* lenses. There is also ample room for the surgeon to wear his own glasses, should he need them.

(3) The instrument is so constructed that the whole front lifts up as a kind of door. The field of ordinary vision thus obtained is quite extensive, and enables the operator to change from X-ray to direct vision at any moment he chooses, and as often as he chooses.



Head Fluoroscope showing open front, with door and detachable metal can.

In practice, the foreign body is found in the ordinary way, in the dark, by the large screen. It is localized, and guiding marks are placed on the skin. The surgeon then makes his incision, and may find the fragment without any further aid. But if he does not at once come upon it at the calculated depth and position, no probing is resorted to, but he at once dons the head fluoroscope. Right angled forceps are provided, the vertical portions of which are of varying lengths, differing by steps of ¼ inch. A pair is chosen slightly longer than the estimated depth; it is then possible so to place the blades that when the foreign body is seen between them, there can be no error in a horizontal plane, and the vertical error cannot exceed ¼ inch. The actual blades are shaped as long ovals, and carefully smoothed, so that it is quite safe to burrow gently with them in the tissues. With a little practice, it is an easy matter to grasp the fragments. Some surgeons, however, see objects on a fluorescent screen very badly, and it is then quite justifiable for the radiographer himself to put on the fluoroscope and to manipulate the forceps. It should be clearly understood, however, that he comes in only at the last moment, when all the real surgical work is done, and all that is needed is to approximate the blades to the foreign body.

The diaphragm should be cut down until the size of the illuminated patch does not exceed 1½ inches square. As the small screen within the head fluoroscope is protected by lead glass, the operator will then run no risk whatever. No protective gloves are needed as the forceps handles are purposely made long so as to be outside the field of action of the X rays.

The instrument above described is made by Messrs. W. Watson and Sons, 196, Great Portland Street, W., and is sold by them under the name of "The Hernaman-Johnson Head Fluoroscope (modified from Wullyamoz)."

The right-angled forceps are made by Messrs. S. Maw and Sons, London.

II.—A Simplified Lewis Jones Condenser Apparatus, arranged for both Diagnosis and Treatment.

The condenser system of nerve and muscle testing introduced into this country by the late Dr. Lewis Jones, is, I feel sure, destined to supersede in great part the older methods. It is not my purpose here, however, to expatiate upon the merits of this system, or even to describe its principle. The latter is fully set forth in Dr. Lewis Jones' writings.

My intention is merely to point out some inconveniences in the present apparatus, and to show how these may be remedied. Owing to difficulties as regards skilled labour at the present time, it has not yet been found possible to place the modified apparatus on the market; but a description may, nevertheless, prove interesting to those who have experience of condenser testing.

The present apparatus has twelve studs, giving impulses lasting approximately from 1/24,000 to 1/200 seconds. One hundred volts is used to charge the condensers. This voltage is, of course, an arbitrarily chosen one, but in order to make findings comparable, it should be adhered to. Considerable work has already been done with this instrument, so that 100 v. ought to remain the standard. 1/200 of a second is not, however, always sufficiently long to excite a badly damaged muscle, and Dr. Lewis Jones arranged for a further set of three impulses, lasting roughly, 1/100, 1/70, and 1/30 seconds. These are obtained by using the last three studs over again at 200 v. and through a resistance of 5,000 ohms. This is brought abont on a 200 v. circuit by taking out the lamps which form a shunt, and by disconnecting one of the leads to the patient and putting it into a third terminal marked R. Thus two distinct manipulations are required, and, in recording results from studs 10, 11, 12, it is necessary to specify whether the test was made with or without the modifications above described.

In order to simplify the procedure and the records, without in any way altering the actual conditions, I suggest that in future the Lewis Jones box should have 15 studs instead of 12. By a not very elaborate arrangement of connections and switches, the mere passing on of the handle from 12 to 13 can be made automatically to bring into play for a second time stud No. 10, but with 200 v. in circuit, and also with the 5,000 ohm, resistance interposed. Similarly, 14 corresponds with a modified 11; and 15 with a modified 12. We thus have 15 studs each giving an impulse of definite time value, and we can record the reaction of muscles on "The Lewis Jones Condenser Scale" by simple numbers. Thus, if in a report we see, "Tib. Auticus. 13. (c.s.)" we know that this muscle needs a condenser impulse lasting approximately 1/100 of a second to excite it.

In the existing instrument the charging of the condensers from the main, and their discharge through the patient is effected by a metronome. This is quite satisfactory for diagnosis, but is for the most part too slow for treatment. An ordinary turbine mercury break may be used to give a rapid charge and discharge. Unless skin sensation is abolished or very much reduced, it is impossible to use the larger impulses—from 7 onwards—with the turbine break, as the very rapid succession of long impulses causes pain. It is just these long impulses which one wishes to use in treating serious nerve-muscle lesions. The muscles may require impulses lasting 1/400 seconds to exercise them, and it is found that the patient cannot bear the skin sensation. This trouble can be got over by using a rotating dipper break in which there are two blades, at an angle of 180°, dipping into separate basins of mercury. These correspond with the two cups of the metronome, the spindle of the break taking the place of the middle cup. By a simple system of gearing the shaft could be made to revolve at any speed between, say, one revolution per second, and twenty. This gives all the range necessary both for diagnosis and treatment.

The present outfit consists of no less than four separate pieces of apparatus, one of which is a heavy turbine mercury break. This makes its use in a ward or a private house extremely inconvenient. By abolishing the metronome, and mounting all the parts on a single board, portability would be secured. It would also be a great convenience if a shunt resistance and voltmeter were provided, so that the apparatus could be readily used on a voltage above 200.

[Note.—Since the above was written Messrs. Watson have undertaken the construction of modified Lewis Jones sets as above described. A speedometer is also attached to the shaft ofthe dipper-break, the speed of which can be very accurately adjusted. It thus becomes possible to record both the length of the individual impulses used, and the number delivered per second.—F. H.-J.]

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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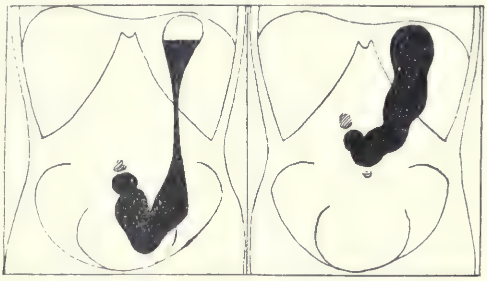
GASTROPTOSIS.

By Arthur F. Hertz, M.A., M.D. (Oxon), F.R.C.P.,
Physician to Guy's Hospital.

Gastroptosis is often diagnosed without considering sufficiently whether it can be the cause of the symptoms which are present. It is in fact an incomplete diagnosis, as it is necessary to know whether the ptosis is present in the erect position only or also on lying down, whether it gives rise to duodenal kinking, and, if so, to what degree stasis results, before an accurate prognosis can be given and a rational line of treatment instituted. The object of this paper is to show briefly how an X-ray examination of the stomach can give accurate information on these points.

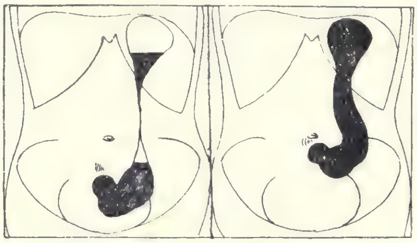
Orthostatic Gastroptosis is the condition present when the *lesser* curvature of the stomach, as seen with the X rays after a standard barium meal, is below the umbilicus in the erect position, but the *greater* curvature is above the umbilicus in the horizontal position. (Fig. 1.)



Vertical. Horizontal.

FIG. 1.—Orthostatic Gastroptosis.

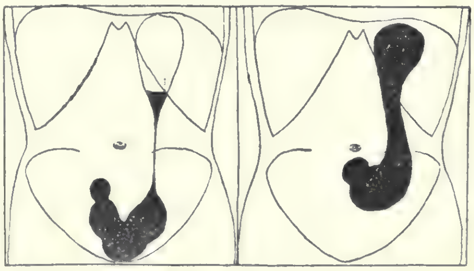
COMPLETE GASTROPTOSIS is present when the stomach is not only abnormally low in the erect position, but the greater curvature also reaches below the umbilicus in the horizontal position. (Fig. 2.)



Vertical. Horizontal.

FIG. 2.—Complete Gastroptosis.

Gastroptosis does not lead to kinking of the pylorus, as the pyloric end of the stomach, together with the first part of the duodenum—the pyloric cap of Cole—is surrounded by peritoneum and is freely movable. It may, however, give rise to a kink where the first part of the duodenum joins the second or descending part, as the latter is situated behind the peritoneum and is normally fixed (Figs. 3, 9 and 10).



(*a*) Vertical. (*b*) Horizontal.

FIG. 3.—Complete gastroptosis with extreme stasis, especially in erect position, owing to duodenal kink. Splashing was felt in the left iliac fossa five hours after breakfast of tea and toast.

In some cases, however, the duodenum drops with the stomach (Figs. 4, 5, and 6) : it is always necessary, therefore, to note the position of the duodenum as well as that of the stomach. It may be said that if the upper extremity of the duodenum is not at least an inch above the umbilicus duodenal ptosis is present.

After having determined the position of the stomach and duodenum in the erect and horizontal positions, it is next necessary to observe whether the stomach is able to evacuate its contents in a normal manner. If the duodenum drops with the stomach, the passage of food out of the stomach and through the duodenum is generally normal in rate. This is also sometimes the case even if the duodenum has not dropped, but in the majority of cases, especially if the ptosis is well marked, it can then be seen with the X rays that although the food may pass without difficulty from the stomach into the first part of the duodenum, there is delay in the passage beyond this point. Similar observations must be made lying down; in many cases it will be found, especially if atony is also present, that the greater part of the stomach drops to the left side of the spine, so that nothing at all passes into the duodenum so long as the patient lies flat on his back, but as soon as he lies on his right side food passes without difficulty into and through the duodenum (Fig. 10 (*b*)), unless a severe degree of complete gastroptosis is associated with a duodenum in the normal position.

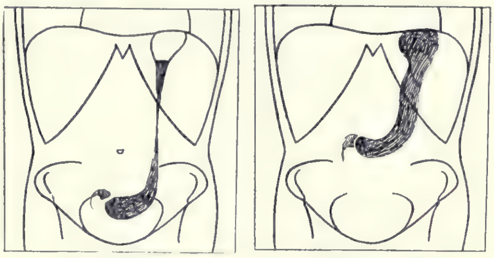

(*a*) Vertical. (*b*) Horizontal.

Fig. 4.—Orthostatic Gastroptosis, with ptosis of duodenum.

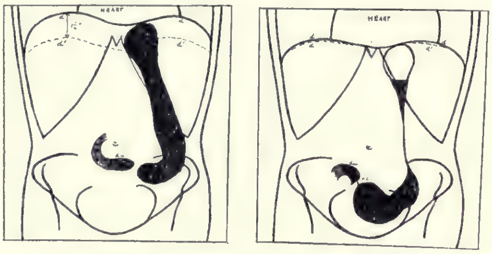
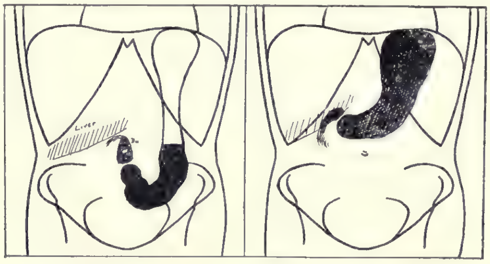


Fig. 5.—Complete Gastroptosis with duodenal (du) ptosis. There is also ptosis of the diaphragm, which resulted in a reduction of the respiratory excursion from 1¼in. in the horizontal to 3-16in. in the erect position.



Vertical. Horizontal.

Fig. 6.—Orthostatic Gastroptosis with atonic dilatation, but no stasis (empty in four hours), owing to duodenal ptosis. The liver is also seen to be dropped in the erect position.

A second examination should be made six hours after the opaque meal, no food having been taken in the interval. The patient should not lie down, but should follow his ordinary occupation until the second examination is made. Gastric stasis is present if the stomach still contains food at this second examination. In order to decide whether this is due to the ptosis or to some complication, such as organic obstruction of the pylorus, a second opaque meal should be given on another day, and the patient should lie on his right side in the interval between the two examinations. If the ptosis is the sole cause of the stasis, the stomach will be empty in six hours, and if an intermediate examination is made it will probably be found to be already empty in three or four hours.

If there is no delay in the evacuation of the stomach in the erect position, indigestion is not likely to be due to the gastroptosis unless this is associated with atony, in which case the symptoms of the latter are exaggerated. It is therefore important to ascertain whether any atony is present. This is readily done by noting the position of the upper level of the gastric contents immediately after the opaque meal has been taken. However great the ptosis may be, the upper level of the contents should not be more than two inches below the highest point of the left lobe of the diaphragm, unless the case is complicated by aërophagy, when the upper level may be temporarily depressed, but it rises again when successful eructation leads to the removal of air from the stomach.

When atony is associated with gastroptosis, the condition I have described as *orthostatic hour-glass stomach* (1) may be present (Figs. 3, 4, 5, 7 and 10.) The walls of a dropped stomach, the tone of which is deficient, do not contract upon the gastric contents, so that the food falls at once to the most dependent part of the organ, which sags deeper and deeper as the quantity of food increases. The upper level of the gastric contents is therefore abnormally low, and only rises slowly as more food enters the stomach. The fundus being fixed, the food and gastric secretion in the most dependent part of the stomach exert a considerable tension upon its body, which becomes more and more stretched (Fig. 7 (*a*)). The passage between the fundus and the dependent part of the stomach becomes narrower and narrower, until finally its lumen is completely obliterated, the stomach being now divided into an upper segment and a lower and much larger segment containing the food and a small

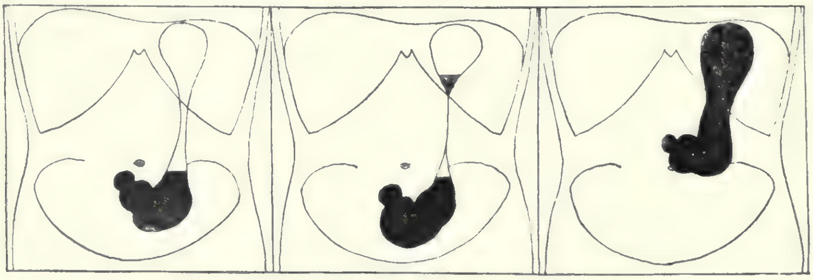

(*a*) (*b*) (*c*)

Fig. 7.—Orthostatic hour-glass stomach.

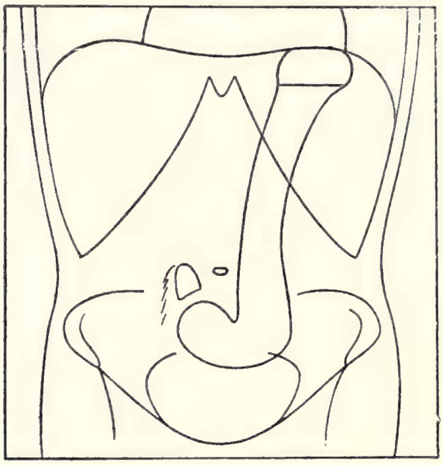
quantity of gas. If more food is now swallowed it remains in the upper part of the stomach (*b*), and small quantities can be seen periodically passing through the neck to join the main portion of the gastric contents. This hour-glass condition of course disappears immediately the patient lies down (*c*). A mistake in diagnosis in such a case would never be made if all patients with suspected hour-glass stomach were examined lying down as well as standing up, and if the patient were examined at short intervals whilst the opaque meal is being taken and not merely at its conclusion, in order that the actual development of the hour-glass condition can be watched. In most cases the narrowing in the centre of the stomach disappears, if the patient contracts his abdominal muscles or pressure is exerted on the lower part of the abdomen. Occasionally, however, the ptosis is so extreme that the lower segment of the stomach is further depressed instead of raised by this means. There is one characteristic common to orthostatic and spasmodic hour-glass stomachs, by means of which they can be distinguished from the organic condition. The upper portion of the stomach is conical in shape, and tapers below to a point from which the food can be seen to pass at intervals through the narrow neck into the lower portion of the stomach. When the hour-glass constriction is organic, the upper division of the stomach is not conical, and part of it almost invariably sags below and to the left of the entrance to the constriction.

It is important to observe whether voluntary contraction of the abdominal muscles in the erect position is sufficient to raise the stomach to its normal position, as if this is the case the prognosis is good, and abdominal exercises and massage, together with the temporary use of an abdominal support, will probably result in a cure. If the stomach cannot be raised to the normal position in this way, the back should be supported by the left hand whilst the lower part of the abdomen is pressed inwards and upwards with the right hand. In most cases this results in raising the stomach to the normal position, which indicates that an abdominal support is likely to give relief to symptoms, though it will not by itself cure the condition.

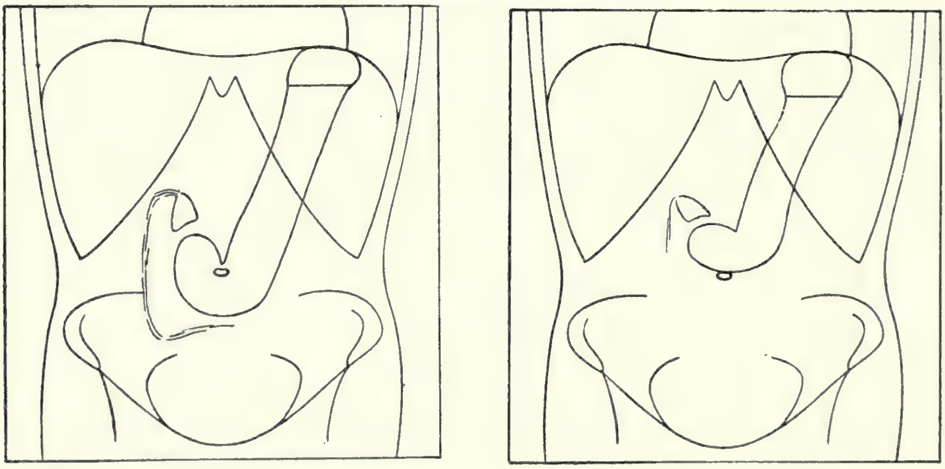
An attempt should be made to find out in what position the stomach empties itself most efficiently, as this is the position the patient should, if possible, assume during and after meals. In most cases the best position is for the patient to lie on his right side with his body slightly raised by being supported on his right elbow. In cases of complete gastroptosis it may be necessary to raise the pelvis, and this would indicate that rest in bed with the foot of the bed raised is required. In severe cases of complete gastroptosis a masseuse should be present at the examination, so that she can see by what manipulations under the fluorescent screen she can raise the stomach to the normal position, as this should be done regularly every day as part of the treatment, the patient being strictly confined to the recumbent position.

When an abdominal support has been ordered with the object of holding the stomach in normal position, an X-ray examination should be made to see whether it really does so. Anyone who is not familiar with such X-ray examination, will be surprised to find how rarely an abdominal support is efficient, but by the addition of pneumatic or porous rubber pads it is possible in many, but by no means all, cases to hold the stomach in normal position.

The final use of radiography in a case of gastroptosis is as an aid in determining the value of treatment. It is often advisable to have an examination made once or twice whilst treatment is in progress, but an examination should



(*a*) January 21, 1913.



(*b*) March 25, 1914. (*c*) July 21, 1914.

Fig. 8.—Gastroptosis cured by abdominal support, massage and exercises without rest.

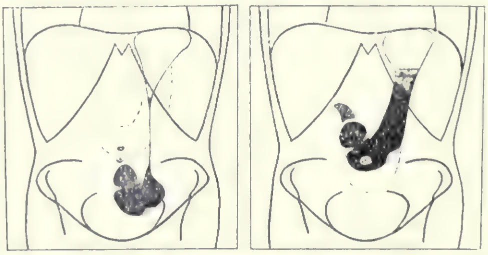


Fig. 9.—Orthostatic Gastroptosis with stasis, cured by treatment.

(*a*) Sept. 16, 1913. Dotted line represents stomach in horizontal position. Weight, 6st. 6lbs. (*b*) May 19, 1914. After six weeks' treatment in bed, followed by use of support. Weight, 7st. 12lbs. A very movable kidney became fixed with the same treatment. Dotted line shows stomach after removal of abdominal support.

at any rate always be made when the proposed course of treatment is at an end, so that it can be seen to what extent the position of the stomach has improved, and whether any further precautions are required (Figs. 8, 9 and 10).

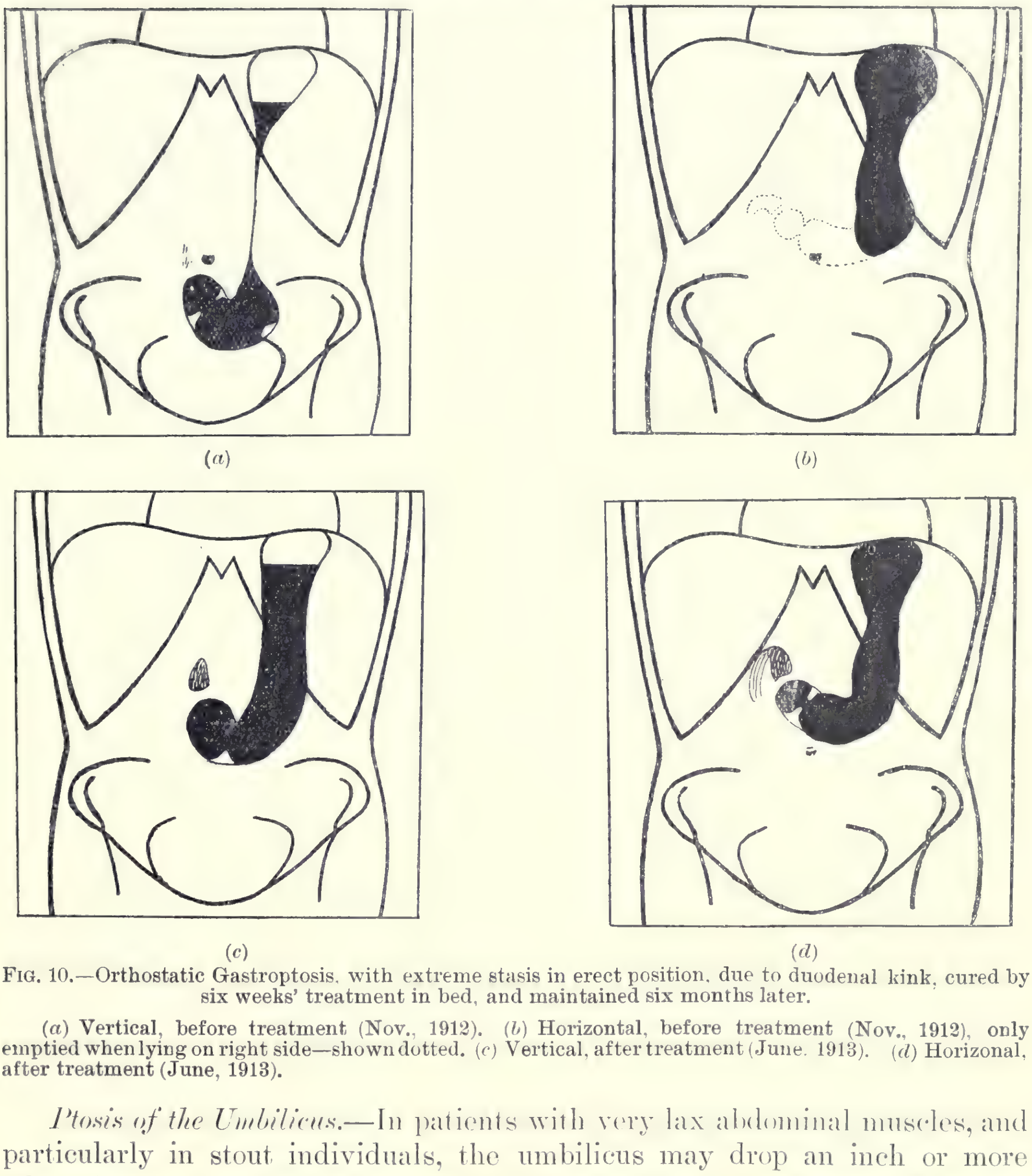


Fig. 10.—Orthostatic Gastroptosis, with extreme stasis in erect position, due to duodenal kink, cured by six weeks' treatment in bed, and maintained six months later.

(*a*) Vertical, before treatment (Nov., 1912). (*b*) Horizontal, before treatment (Nov., 1912), only emptied when lying on right side—shown dotted. (*c*) Vertical, after treatment (June, 1913). (*d*) Horizonal, after treatment (June, 1913).

Ptosis of the Umbilicus.—In patients with very lax abdominal muscles, and particularly in stout individuals, the umbilicus may drop an inch or more when the erect position is assumed. If the position of the lesser and greater curvature of the stomach in such a case is estimated in its relation to the umbilicus, a considerable degree of ptosis of the stomach in the erect position may remain unrecognised owing to the simultaneous ptosis of the umbilicus (Fig. 11). The possibility of this error can be prevented by hanging a penny by means of a long piece of strapping from the ensiform cartilage, its sticky surface being covered by a second piece of strapping to prevent it from sticking to the skin. If the penny is put over the umbilicus when the patient is lying down, its position will remain unaltered when he stands up. An alternative method is to ignore the umbilicus altogether, and to make measurements from the iliac crest, but this landmark is less easily seen, particularly in stout patients.

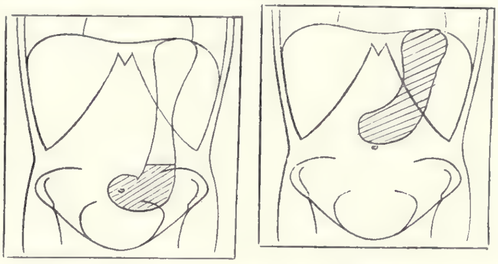


FIG. 11.—Orthostatic Ptosis of stomach (with atony) marked by ptosis of umbilicus.

THE ROENTGEN DIAGNOSIS OF FRACTURE OF THE SKULL.

BY W. H. STEWART AND W. H. LUCKETT, of New York.

THE structure and dome shape of the skull with its double deck of compact substance and intervening cancellated material, its ribs and bridging and tressling, its thickened protuberances at prominent and susceptible points, the peculiar dovetailing of the sutures, its shape and movability, the elasticity of the outer table, the overlapping of some bones, the density and mobility of the scalp, all combine to make this casing for the vital structures resilient to external violence. It has, however, due to lack of uniformity of thickness, weak points which are particularly susceptible to injury. These are the centres of the orbital plates of the frontal bones, the middle cerebral fossa, the centre of the squamous portion of the temporal bone and the centre of the inferior occipital fossa. The thin points seem to have a direct bearing upon the location of fractures, particularly of the bursting linear fractures extending into or originating in the base, from blows on the thicker expanse of bone forming the vault or blows on the point of the jaw, or from violence transmitted upwards from the spine, as falls on the buttocks.

Because of the shape of the skull, its elasticity, its closely fitting covering of skin, muscle, fascia and periosteum on the outside, and the pressure of the intracranial contents and dura mater, on the inside, fractures of the skull have a strong tendency to immediately replace and maintain themselves in position. For this reason, a fracture of the skull subsides into secondary importance. The vital considerations are the amount of injury to the blood-vessels, intracranial nerves, dura and brain substance and the secondary conditions arising therefrom. But as a clue to the location of the serious lesion, the fracture is of utmost importance.

It is a noteworthy fact that each succeeding collection of statistics of the relative frequency of fractures gives this injury an increasing percentage. Thus: Gurlt gave 1·45 per cent.; Von Bruns gave 3·4 per cent.; Chudosky gave 3·8 per cent. These figures we believe, in view of more accurate diagnosis with the Roentgen ray, are altogether too low. If a systematic X-ray examination were made of all injuries of the head, direct or indirect, we are sure it would be demonstrated that the relative frequency of fractures of the skull would show a much larger percentage.

Every skull receiving violence, imparted either directly or indirectly, with or without symptoms of intracranial injury, should be considered possibly fractured until proven otherwise. Fractures of the skull can result from apparently trivial causes without any external manifestation of an injury, and without any symptoms of intracranial pressure. The X-ray frequently demonstrates this lesion where there were no symptoms ; nevertheless, it is very important to diagnose a fracture for the possible occurrence of remote sequelæ, etc.

From our experience, we do not hesitate to say that the majority of fractures of the skull are not diagnosed as such and remain undiscovered.

For these reasons, we venture to emphasize the aid that can be rendered in discovering and locating such fractures by means of the Roentgen ray.

We are all conversant with a number of cases where the fracture with a lacerated bleeding artery is remote from the point of injury. Localization by the Roentgen ray in these cases is of inestimable value.

The frequency with which fracture of the skull is mistaken for various other conditions, especially in cases of coma, calls for any method which will make a rapid and positive diagnosis. There are a number of cases of fracture of skull in which the diagnosis can be made only by the Roentgen ray. We refer to those which have no symptoms, either objective or subjective, only a history of a fall. In the Harlem Hospital every patient who receives a blow on the skull or point of the lower jaw, either directly or from a fall, is considered as suffering from a fractured skull unless proven otherwise. The signing of a release holding the Hospital blameless is always required when such a patient desires to leave.

With the advent of warm weather comes the open window, the use of the streets and yards as playgrounds, the roofs and fire-escapes as sleeping places ; these factors are the source of many accidents in children, and common among them is the fractured skull. The frequency of a serious fracture in small injuries of the head in children and the apparent insignificance of such fractures has often been observed. That skulls of children fracture easily without injury to the brain or blood vessels is the conclusion. When there *is* some injury to the vital tissues the extensive nature of the fracture relieves the tension, in other words the skull decompresses itself. The elasticity of the bones of the skull in children is largely accountable for the rarity of basilar involvement ; this is in marked contrast to this injury in adults, where authorities claim eighty per cent. of linear fractures of the vault extend into the base.

Just why roentgenographing of the skull for a possible fracture, like roentgenographing any other bone for diagnostic purposes, has been so generally neglected, practically ignored, is one of those peculiar anomalies that creep into the routine work of medical practice.

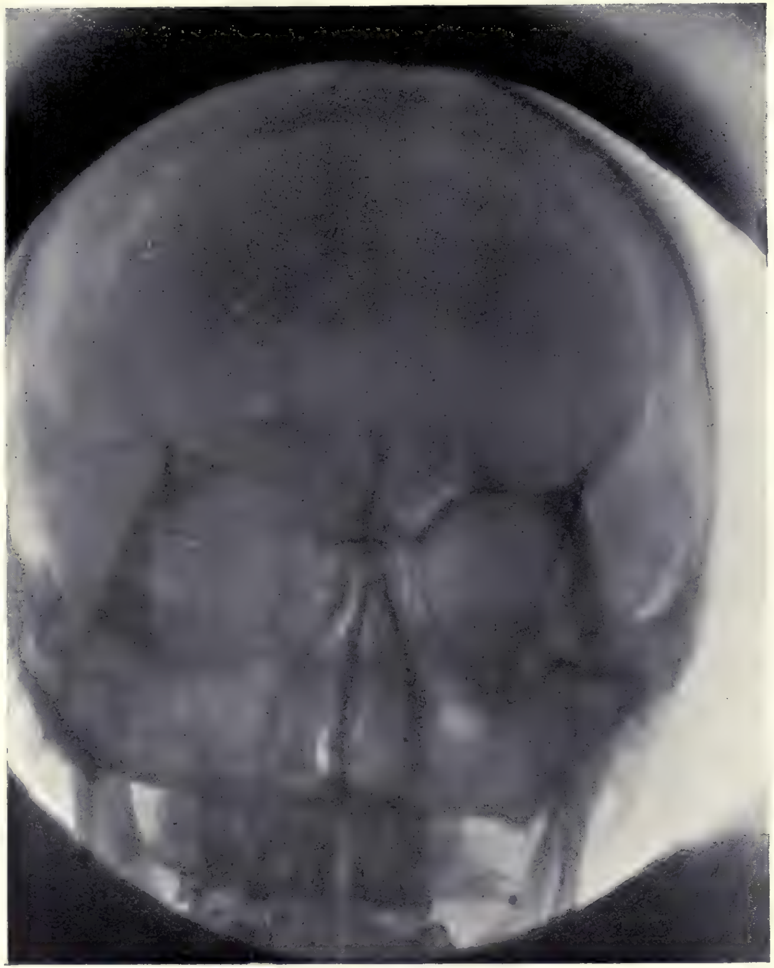
Patients are often in a comatose or irritable condition when referred to the Roentgenologist, and a great deal of patience and perseverance is required. It must be constantly borne in mind that the minimum amount of disturbance and movement is the rule. The head must be absolutely fixed and all respiratory movement overcome.

If the objective symptoms, such as bleeding from the ear, laceration of the scalp, hematoma or paralysis are present, they are a clue to the possible site of the fracture, and attention is naturally directed toward that region ; this must not mislead one, however, for every examination should cover the frontal, parieto-temporal, occipital, and basilar regions.

In the examination of the frontal region we should endeavour to show on our roentgenograms as much of the vertical plate of the frontal bone as possible. This is best obtained by placing the patient flat on the abdomen, with the head, face down, resting on an inclined plane at an angle of twenty-five (25) degrees. A small cone having an outlet of about five (5) inches is used ; the vertical axis of this cone represents the central ray and should be centred on the glabella and directed straight down. A tube of rather high vacuum, which will take about forty-five (45) to fifty (50) milliamperes, is used, and an exposure of about five (5) seconds given. This procedure, in the majority of cases, will give us satisfactory roentgenograms of the frontal region. It is frequently the case, however, that our patient's condition will not allow the manipulation necessary to place him in the above position. The procedure must then be reversed, the tube being placed beneath and the plate above.

In the temporo-parietal region we should show that portion of the skull lying between the sagittal suture above, the coronal suture anteriorly, the lamboidal suture posteriorly and including the entire temporal bone. Both sides of the head must be examined. The patient lies on the table with the head resting easily on a raised platform having a special adjustable fixation apparatus attached. A cone with an outlet of seven (7) inches is used. The central ray should be centred at about the mid-temporal region and an imaginary line, extending from the frontal eminence to the centre of the chin, should be parallel to the lower edge of the cone ; this will overcome any conflicting shadows from the opposite side of the head. The same conditions govern the tube as when examining the frontal region, except that the exposure should not be over three seconds.

The occipital or posterior fossa is best examined by having the patient lie on the back, the head with the chin sharply flexed, resting on an incline of 25 degrees. This brings the occiput flat down on the plate. Fixation having been made, a cone with an outlet of four (4) inches is used, the vertical axis being centred on the foramen magnum ; the tube is placed at an angle of fifteen (15) degrees back of the vertical axis and directed towards the foramen magnum, the upper edge of the cone being just above the supraorbital



No. 1. Fracture of the vertical plate of the frontal bone.

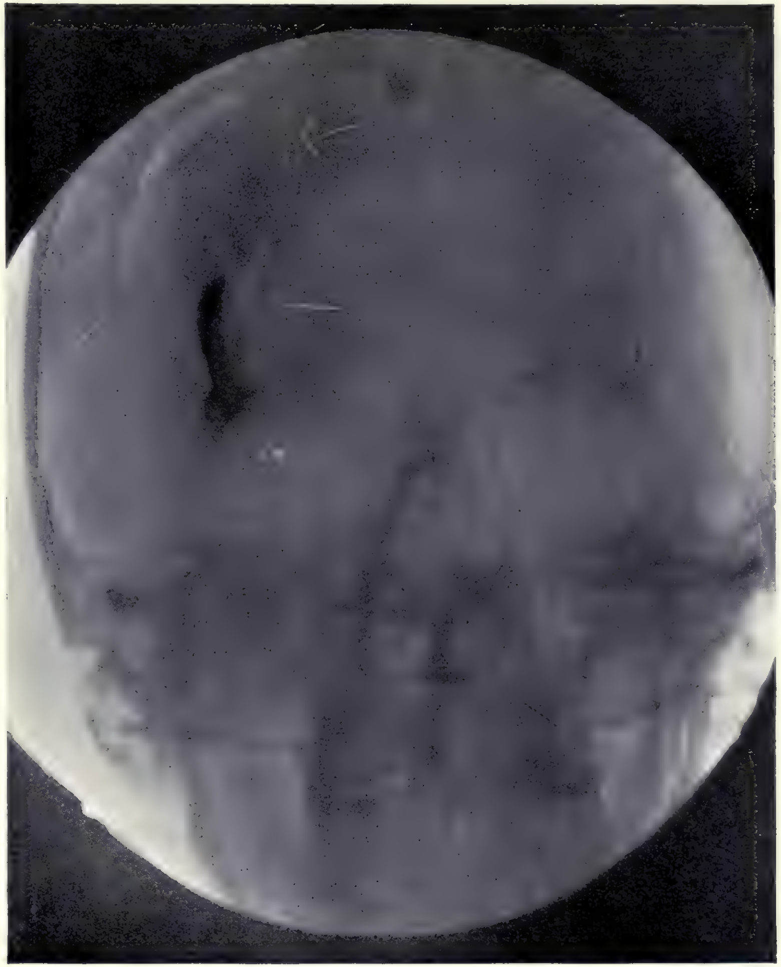
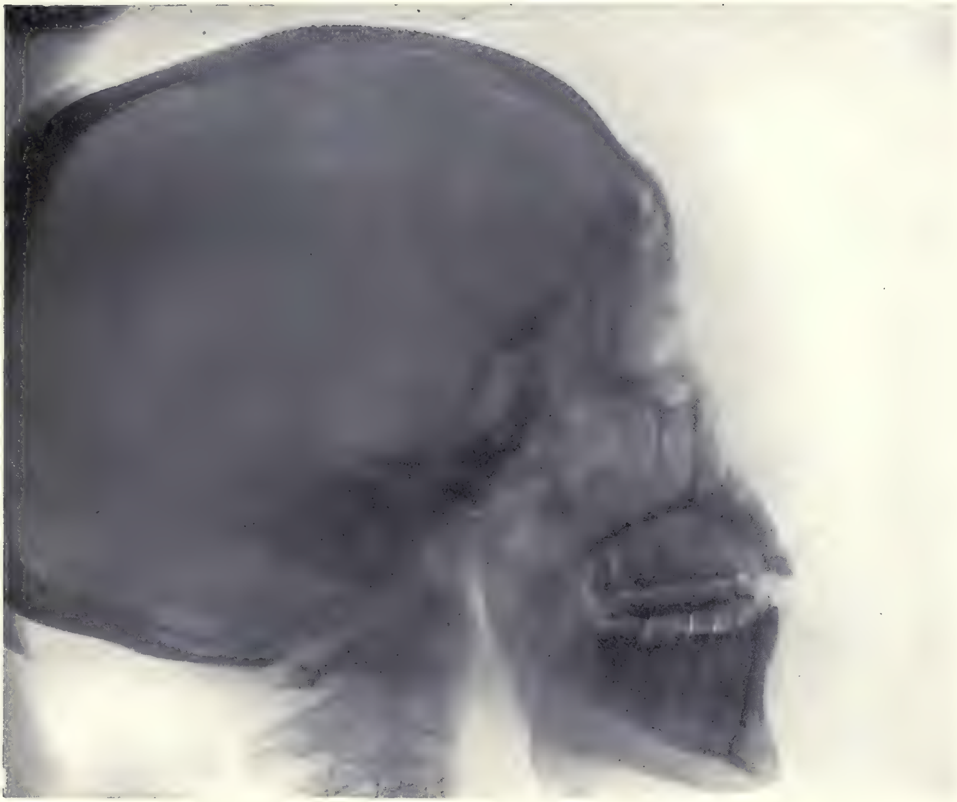
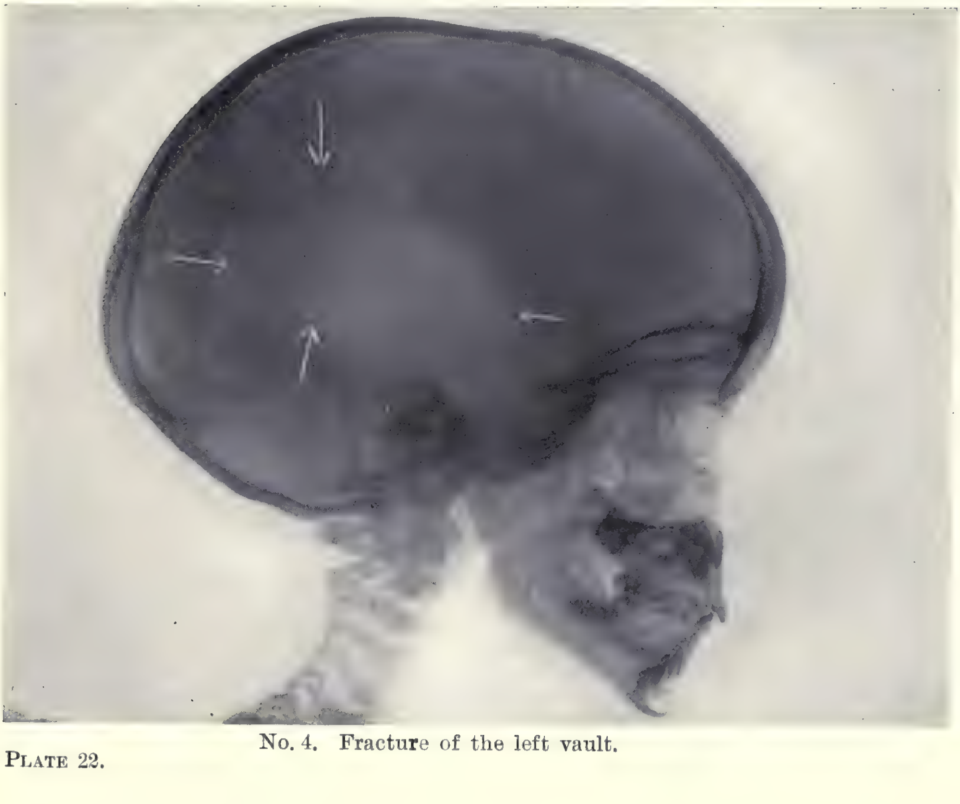


Fig. 2. Fracture of the left vault; numerous "forks" extending forward into the vertical plate of the frontal bone.

Plate 21.

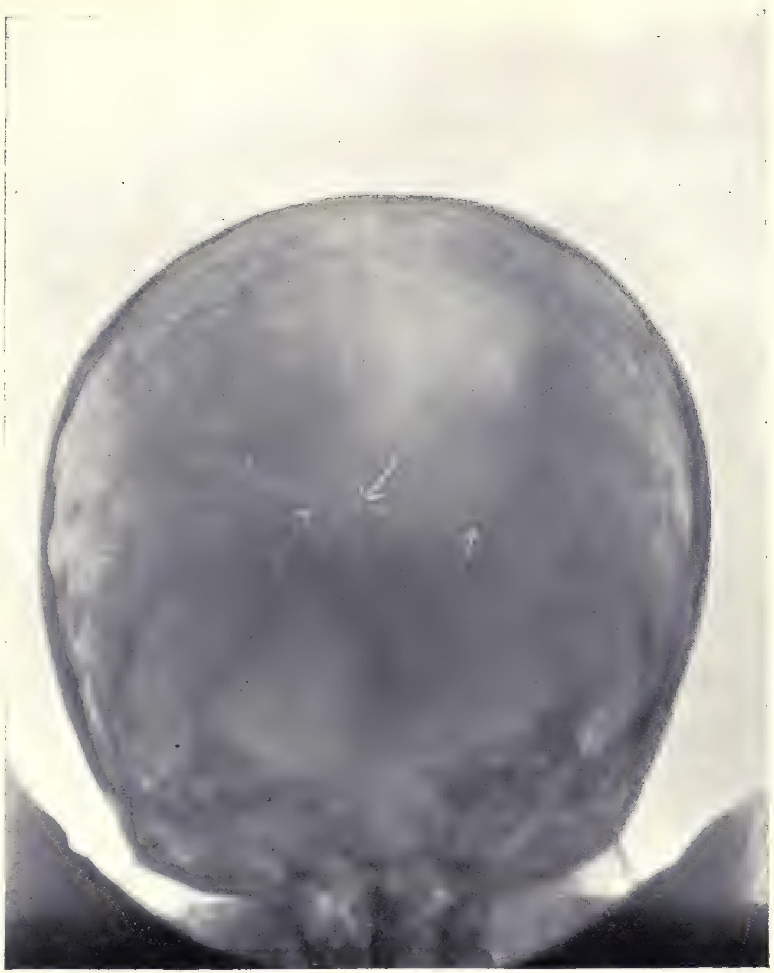


No. 3. Fracture of the right vault.

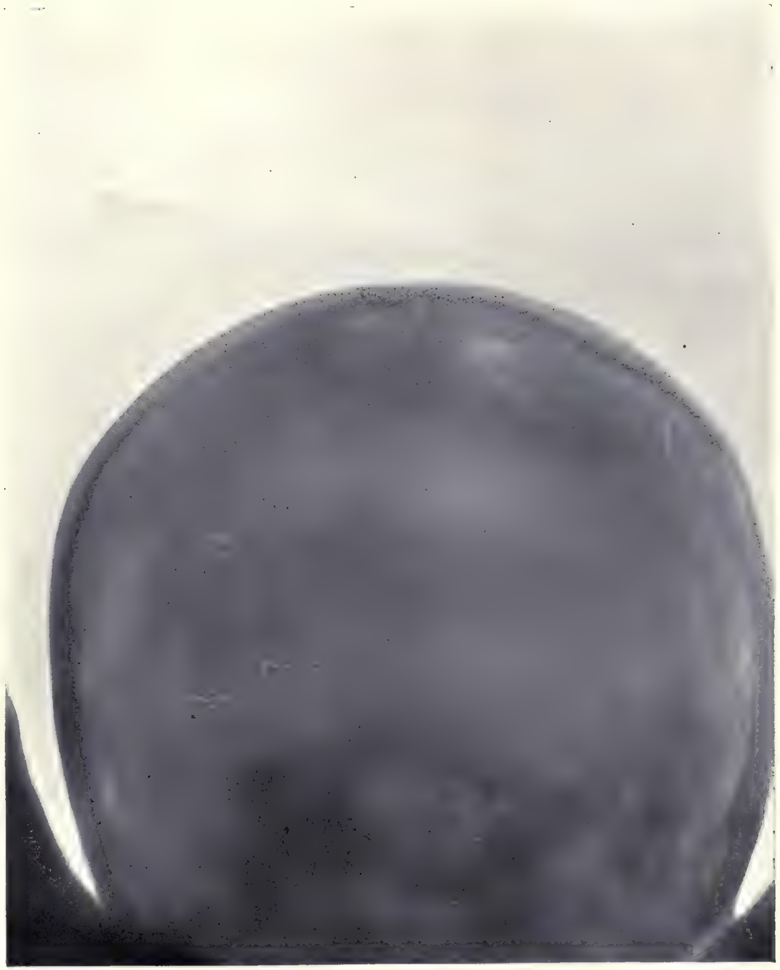


No. 4. Fracture of the left vault.

PLATE 22.



No. 5. Transverse fracture of the occipital bone extending into the right parietal region.



No. 6. Vertical fracture of the occipital bone extending downward and inward with a fork extension of the foramen magnum.

Plate 23.

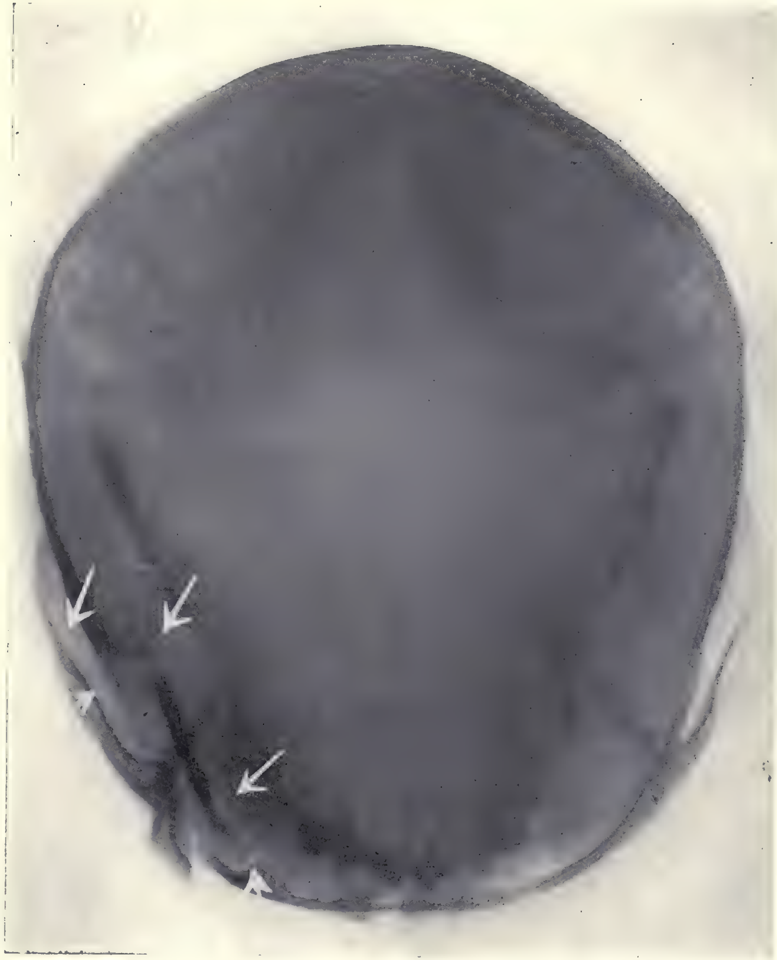
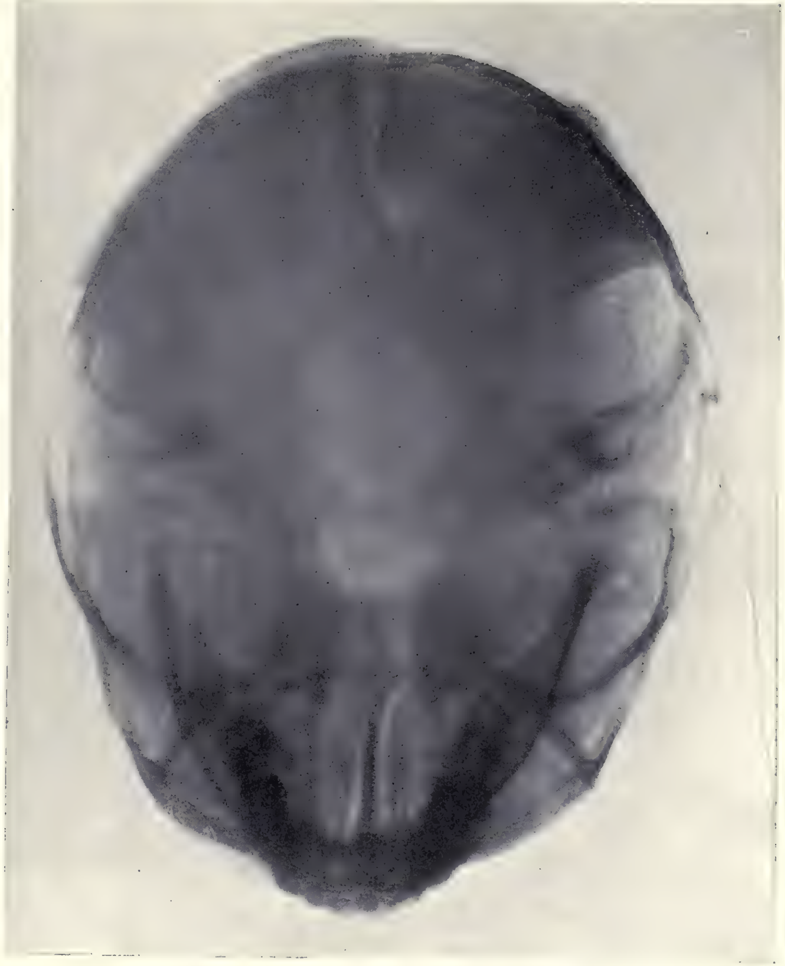


Fig. 7. Fracture of the base of the skull with a comminution of the anterior and middle fossa.



No. 8. Fracture of the anterior fossa.

Plate 24.

ridges. A high vacuum tube is used and an exposure of five (5) seconds is made.

At a meeting of the American Roentgen Ray Society, held in Cleveland on September 11, 1914, Dr. David R. Bowen of Philadelphia called attention to a new technique which he was using for the examination of the sphenoidal sinuses. The roentgenograms obtained gave a true representation of the base of the skull. This method at once appealed to us as an excellent adjunct to the technique in examination of the skull for fracture.

The Roentgenologist has learned that fracture of the base of the skull is more of an exception than a rule ; in fact, we have found that the prevailing fractures are of the vault, only a small proportion having a " fork " extending into the base. The importance of a complete examination of the globular skull in the negative Roentgen diagnosis of a fracture can be readily appreciated. With the addition of an examination of the base I now feel that such negative diagnosis can be made with certainty. The technique is as follows :

The patient lies in the ventro-dorsal position on a table which can be raised or lowered at the will of the operator. The head is dropped over one end and the table raised until the top of the head rests on an incline of about twenty (20) degrees, which is permanently fixed on an auxiliary stand. A plate is placed upon this incline beneath the skull. The surface of this plate should be parallel with the line of the base of the skull extending from the external auditory canal to the glabella. The head is immobilized by placing over the chin a muslin bandage, the ends hanging down on each side of the stand and weighted with small sand-bags. With a small cone the tube is centred over a line drawn from the point mid-way between the tip of the cricoid cartilage and the chin to just anterior to the external auditory meatus ; this line should be as nearly as possible perpendicular to the base line and the plate. The tube should be of good penetration and the exposure rather long.

In counterdistinction to the examination of the sphenoidal sinuses, where it is desirable to throw the shadow of the lower jaw well forward to uncover the sphenoids, the mandible should be held slightly back so that the anterior fossæ are brought well in view, as this is a favourable location for fracture of the base.

It is remarkable how patients, unconscious or in a semi-conscious condition, take to this position without resistance. A little patience on the part of the operator, combined with a hypodermic of majendies, when necessary, will usually succeed.

INTERPRETATION.

In the interpretation of these roentgenograms of the base of the skull, beginning behind, we see the foramen magnum and within the odontoid process of the axis. Just forward from this opening, on either side, the mastoids are distinctly reproduced with the associated shadows of the petrous portion of the temporal bones. Anterior to this is a clear view of the middle fossa. If we have not produced too much extension of the chin, the anterior fossa can be seen well in front of the overlying shadow of the lower jaw. Fractures of the zygomatic arch with the amount of displacement are beautifully shown with this technique.

In the interpretation of the frontal, lateral and basilar regions we have to remember the normal radiating lines cast by the grooves on the inner table of the skull accommodating the meningeal blood-vessels. These grooves spread out fan-shaped from an anterior point backward. We must also remember the shadows cast by diploic spaces between the inner and outer tables of the skull which accommodate the venæ diploicæ ; these lines spread vertically upward from a point at the base directly in variance to the lines representing the meningeal grooves.

Fractures usually show as light, sharply cut lines of varying width depending upon the amount of separation, and are generally in direct variance with the normal shadow lines.

RADIOTHERAPY: ITS SCIENTIFIC BASIS AND ITS TEACHING.

By J. Joly, Sc.D., F.R.S.

Read March 23, 1915, reprinted by kind permission of the Council of the Royal Dublin Society.

(Continued from page 120.)

We now turn to the living cell.

We find that radiation may, if carefully modulated, stimulate, and, if too intense, retard its growth, and ultimately destroy the molecular structure required for mitosis. In so far the effects on the growth of the cell—superficially, at least—resemble those on the formation of the latent image.

It is also found—and, as already stated, the whole efficacy of radio-active treatment turns upon this—that in the case of the pathological cell these phenomena appear all in advance of the like effect in the normal cell. There exist then states of the cell differing in sensitiveness towards radiation just as there exist differing states of the film.

The accelerated mitosis and growth of the pathological cell appear in some cases to be traceable to repeated mechanical stimuli. This is parallel with the formation of the latent image by similar stimuli.

Finally, the destruction of the pathological cell is said to be brought about by thermal radiation of a certain intensity. A method of treatment has even been founded on this. The parallel with the latent image also appears here.

There is, then, a very complete parallel between the effects of radiative and mechanical stimuli in both cases, the latent image and the cell. The formation of both may be promoted by radiation, and by the same radiation in excess may be finally destroyed. It seems permissible to ask if the same parallel does not extend to more definitely chemical effects. The point is important, not only on the score of the convenience and accessibility of the plate as a means of investigation, but because of certain conclusions which can be drawn from already known data, and which possibly possess a bearing on what is termed the cancer problem.

We may state the argument thus:—We find certain chemicals producing in the film what are to all appearance identical effects with those generated in it by radiation. And reasoning from the fact that radiation produces parallel results in the case of the cell and the film, we ask if those chemicals which affect the latent image in the direction of acceleration or retardation may not also in like manner affect the cell. The view that this question is legitimate is supported by some observational facts, as will presently appear.

But first it is necessary to look more closely at what may be really involved in comparing the formation of the latent image with the growth of the cell. If, at any stage of its metabolism, a partial (or complete) reducing action takes place in the cell in which the halogen and the colloid present take a part, the similarity between the two results may be more than a parallel. It may be based on actions chemically or physically identical, or practically so. There may, in fact, exist, as a stage in the life of the cell, relations between the negative halogen ion, a positive ion united with this, and the protoplasm, similar to that prevailing among the elements of the film. If such exist, the explanation of the resemblance in the response of the two systems towards different agents, physical and chemical, is at once forthcoming. We are not in this case involved in the statement that the growth of the cell and of the latent image are parallel actions beyond the inference that a certain molecular re-arrangement necessary for the growth of the cell is similar in character to what is presented to our study in the formation of the latent image. In a sense the formation of the latent image is katabolic, that of the cell is anabolic. We are not, however, forcing a complete comparison between them, nor do the observational facts call upon us to do more than recognise *some* photo-sensitive molecular process involved in cell-growth similar to one involved in the formation of the latent image.

There seems to be no doubt that the growth of the cell is highly sensitive towards ionic concentration. Confirming and extending the results obtained by Loeb in 1898, and using similar methods, Moore, Roaf, and Whitley have found by direct observations on the embryonic cells of Echinus that even small increase in the concentration of the negative ion $(\overset{-}{\mathrm{HO}})$ will accelerate growth.(16) But if the alkalinity be increased yet a little, pathological mitoses make their appearance, and at a slightly greater alkalinity the chemical actions necessary for the life and metabolism of the cell are inhibited. On the other hand, an increased concentration of the positive ion $(\overset{+}{\mathrm{H}})$ from the first retards, and, if pushed further, inhibits growth. The parallel with the action of alkaline sensitisers and acid retarders upon the film is obvious.

Observations showing an abnormal lowering of acidity in the digestive secretions of cancerous patients have been made by several investigators.

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(16) Moore, Roaf, and Whitley, Proc. Roy. Soc., Ser. B, vol. lxxvii, October, 1905.

Messrs. Moore, Roaf, and Whitley in 1905 found that the diminution of hydrochloric acid in the stomach was independent of the location of the disease.(17) Copeman and Hake, in 1908, published results which failed to confirm those of Moore.(18) The question as regards the secretion of HCl cannot be regarded as finally settled. But a lowering of acidity as a frequent feature in cases of malignant disease seems to be accepted as proved. With old age a similar phenomenon is observed, and with advancing years the liability to cancer increases.

These facts suggest that the antagonistic action of the acid and the alkali in the cell is parallel with the antagonistic action of restrainer and sensitiser upon the film. The latter may be illustrated by a simple experiment on the film. A latent image is formed on a dry plate, either by brief exposure to light or by application of a sensitiser. The application of a wash of very dilute HCl left on the plate for a couple of minutes will then obliterate the latent image, as will be found upon applying a developer. The effect is best obtained with highly dilute acid. Such a strength as is said to prevail normally in the secretion of the stomach—0·2 to 0·4 per cent.—works effectively.

The possibility that substances which act as sensitisers or restrainers on the film may act to promote or retard mitosis in the cell must be admitted from these results, some of which are obtained by direct experiment on the living cell.

The fact that cancer of tongue, lip, and throat, and generally of parts around the mouth, is chiefly confined to the male sex has before now been regarded as raising a suspicion as to the injurious effects of tobacco smoking.(19)

The effects of a solution of the volatile substances evolved from burnt tobacco, upon the film, support this inference. If tobacco smoke is bubbled through water, and a little of this water is poured on a photographic plate in the dark, and again washed off, a vigorous latent image will be obtained, as development will demonstrate.

Now C. and R. Hertwig and Galleotti (20) mention nicotine as one of a few substances which they found, by direct observation on animal cells, produced pathological mitosis and derangement of cell-division closely similar to those which are observed in cancer growth.

It is evident that we may find, in this indication of the film, support for our line of reasoning. The substances present in tobacco—probably the intensely alkaline substance nicotine in chief—set up in the cell those same electro-negative conditions which cause or assist it to promote the formation of the latent image, and in this way locally precipitate a state of mitotic instability which from other causes—to be presently discussed—may prevail as a tendency throughout the body cells of the patient. Local mechanical stimuli may contribute. It is, of course, not impossible that in many cases of the kind the effect is so far due to the local causes that but for these the cancer would not anywhere have invaded the body.

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(17) Moore, Roaf, and Whitley, Proc. Roy. Soc., Ser. B, vol. lxxvii, May, 1905.

(18) Copeman and Hake, Proc. Roy. Soc., Ser. B, vol. lxxx., June, 1908.

(19) Statistics of cases treated in the Middlesex Hospital in 1913 show that the number of cases of the kind in the male and female sexes stand as 8.3 : 1. Archives, xxxiii., p. 2.

(20) Referred to by Moore, Roaf, and Whitley, Proc. Roy. Soc., Ser. B, vol. xxvii., October, 1905.

According to Dr. W. S. Bainbridge ("The Cancer Problem," p. 67 ; New York : The Macmillan Co.), "cancer of lip, tongue, cheek, and buccal mucous membrane is of relatively frequent occurrence in both sexes in India, in consequence of the chemical irritation produced by the chewing, or holding in the mouth, of a mixture of betel leaves, areca nut, tobacco, and slaked lime."

The seeds of *Areca catechu* are rich in tannin and also contain arecolin, an alkaloid closely related to nicotine, being, in common with it, a derivative of pyridine. Choline, a strong base answering the general reactions of alkaloids, is also present. The betel leaf is the leaf of *Piper betle*, and contains yet another alkaloid of the pyridine group—piperine (Haas and Hill, "Chemistry of Plant Products" ; London : Longmans, Green and Co., 1913). It is worth noting that in this case both sexes suffer the increased liability to mouth cancer, and both sexes indulge in the habit.

An increase in the number of deaths from malignant disease within recent years is admitted by high authorities to be the only conclusion we can draw from the statistics, after every allowance for error has been made.(21) Modern advances in surgical and medical science undoubtedly enable life to be prolonged in many cases, or even cure to be effected where formerly speedy death alone must ensue. This ought to be a set-off against improved diagnosis as a source of error in the statistics. If this increase is a fact, we have to look around for the cause. It is, assuredly, not founded in anything of an evolutionary nature. I say this because if its origin be in the cell itself, a very profound change—profound because seated in the primary organic structure—must be supposed to have taken place within a few decades. Indeed, if the increase is what we judge it to be from the figures, it has taken place within a single generation, or at most two generations. This quite precludes evolutionary change acting through Mendelian factors. The view that some general body-change is involved appears to be supported by the fact that local causes will initiate the disease in some subjects and not in others. Consequently we must look to some article of diet or some custom of life which can reach and affect the stability of the cell. There are obvious difficulties in laying the blame for a change so deep-seated on a custom. Moreover, we look in vain for any custom at all likely to be responsible. When, however, we come to the possibilities of diet, we see much less difficulty.

In view of what has already been stated, it is legitimate to pursue the matter yet further, and to ask if within recent years we are not taking into our bodies more abundantly than formerly some substance or substances which might be held responsible for the increase of cancer. Many accustomed articles of diet may, doubtless, contribute in some degree towards abnormal cell mitosis and yet be quite harmless under the conditions of consumption. As already stated, it is known that alkaline solutions of lactose and glucose possess the parallel qualities required for affecting the photo-sensitive films. I have not obtained this action on the ordinary dry plate, nor got any latent image with ordinary sugar in alkaline solution. Milk, however, gives a faint effect, and this may be due to lactose. Sugar is an article of diet the consumption of which has increased in modern times, and the evidence for its sensitising activity—either directly or indirectly—should not be lost sight of as possibly concerned in the cancer problem ; although it must be regarded as *a priori* improbable that a great natural food would act in this way.

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(21) See "Encyclopædia Britannica," last ed. Art. *Cancer*. Statistics for cancer in England and Wales (1912) show the highest mortality till then recorded. (*Daily Mail Year Book*, 1915.) The more recently issued statistics for 1913 reveal a still higher death rate.

A more suspicious substance is found in tannin. This substance enters, as all know, largely into the composition of teas of all varieties to the extent of, usually, 11 to 26 per cent. ; and 60 to 80 per cent. of this is obtained in the normal extract. Tea, as an article of diet, has replaced all other beverages in the light meals of the day. This especially applies to the better-off classes. In former years this beverage was only taken at "tea-time." The cancer statistics when compared with the statistics for the consumption of tea in this country show features in common. Both curves rapidly rise for several decades preceding the last, and within recent years show a somewhat less rate of increase.(22)

As regards the consumption of tannin in other countries, it is to be remarked that this substance enters into coffee to the extent of about 22 per cent., and is present in red wines. Obviously without statistics both as to the consumption of tannin-containing beverages and of the prevalence of cancer we cannot discuss the geographical evidence. It is stated that in China cancer has long been a prevalent disease. In Australia tea is said to be largely consumed. The cancer death-rate is reported to be as large as in Great Britain, and to be increasing.

Tannin or gallotannic acid is itself a photographic sensitiser, and has long been known as such. It absorbs the halogens.(23) It is the parent substance of a complicated and only partially studied group of substances in which the reducing properties required for development and sensitisation seem to prevail. Thus gallic acid, a derivative which does not coagulate albumen, and is said to be absorbed in the body by administration of tannic acid, is a developer and sensitiser. Another derivative is the powerful developer pyrogallic acid, which along with gallic acid is stated by some writers to be excreted by the kidneys. As transported in the circulatory system these substances must, of course, acquire neutral or faintly alkaline characters. Other substances which possess the requisite reducing properties, and are constituents of the complex tannins, are pyrocatechol and hydroquinone.

Thein (or caffein) does not appear to exert more than a very feeble effect on the film, even when in a state of saturated solution, either neutral or distinctly alkaline. This substance is stated to be excreted unchanged.

If the increased prevalence of cancer is wholly or in part traceable to the

(22) Compare figures given for tea-consumption in Thorpe's "Dictionary of Applied Chemistry," art. *Tea*, with the Cancer Tables in Burns's "Vital Statistics Explained." (London : Constable, 1914.)

(23) Meldola, *loc. cit.*, p. 68.

increased consumption of tannin, we must regard the derivatives of this substance as predisposing the cells throughout the body to the incidence of the disease. The appearance of the disease at any particular point in the body is probably determined by local stimulus of cancerous mitosis. The view suggested is that a general instability or irritability is promoted throughout the body cells by this substance tannin ; or rather, by the derivative or derivatives of it which are absorbed in the body ; the effects being mainly due to the reducing properties. A state is at length reached after long and excessive absorption of the injurious substance in which local causes are competent to precipitate the pathological mitosis and cell proliferation. These causes are various. It may be a local chemical stimulus, as by the application of a powerful sensitiser such as nicotine, or possibly "nut-gall ointment." Other local causes, as has often been suggested, may be the increased mitotic activity prevailing in the organs of generation. Here there is already a local approximation to the conditions induced by increased electro-negative ionization. Dr. Lazarus-Barlow's results on the segregation of radium in cancerous tissues may indicate yet another local cause. Mechanical stimuli are probably responsible for the sweep cancer, etc.

The frequent recurrence of cancer after its local extirpation or destruction follows as a matter of course according to the present views. For, even apart from metastatic spread of the disease, the local cure is likely to be only temporary if the patient continues to absorb the sensitising agent into his system, or, possibly, has already permanently affected his tissues by its use. Where so much is involved, should not the physician consider the advisability of the denial to the patient of tannin-containing beverages?

The effect of tannin as an influence on mitosis is very probably responsible for the phenomenon of "vegetable cancers" or galls on trees or shrubs. Galls may contain up to 75 per cent. of tannin. These growths originate under the stimulus of irritation by some insect. Pfeffer, Sachs, and others have recognised that tannin in plants is abundant in places where growth is specially active ; such as growing points, pathological growths, and places where the protoplasm is specially irritable.(24) We must remember that when we come to the cell there is not so much to differentiate the vegetable from the animal.

(24) Haas and Hill, "Chemistry of Plant Products." (London : Longmans, Green, and Co., 1913.)

TWO CASES OF ELECTRICAL BURN SUCCESSFULLY TREATED BY IONISATION.

By Alastair MacGregor, M.D., C.M. (Edin.),
Chief Assistant, Electrical Department, St. Bartholomew's Hospital.

Burns from electric cables are so notoriously sluggish in healing under the usual *régime* of ointments and lotions that the following notes of two cases rapidly healed by means of ionic medication may be found of interest. Both patients attended the Electrical Department of St. Bartholomew's Hospital.

Case 1.—J. K., Private —— Highlanders, æt. 26, attended the department on January 21st, 1915. Previous history:—Two years ago when working as a cable-hand received a cable-burn on the back of his right wrist, attended hospital; burn healed after five months' treatment. Eight months before admission cicatrix of burn broke down after injury, but subsequently healed. Thirteen weeks before admission, owing to "cold and a blow," cicatrix once more broke down; treated in hospital with various lotions and ointments. As ulcer would not heal patient was sent to Electrical Department, St. Bartholomew's Hospital.

Condition on admission. Linear ulcer $1\frac{1}{4}$ inches by $\frac{1}{4}$ inch on back of right wrist, some granulations at edge, slight suppuration at base. Treatment: Area of ulceration was dabbed over with 1 per cent. solution of sulphate of zinc, small pledgets of absorbent cotton wool soaked in the same solution were evenly packed into ulcer, slightly overlapping the edges. Over this packing the end of a conducting cord previously wrapped round with absorbent cotton wool soaked in 1 per cent. solution of sulphate of zinc was applied, bandaged on, and connected with the positive pole. The negative electrode was applied to the upper part of the forearm. Current was turned on and gradually increased to 10 m.a.—treatment lasted for twenty minutes. After treatment ulcer dressed with sterile gauze wrung out of 1 per cent. solution of sulphate of zinc; anterior splint applied to hand and forearm.

January 25th.—Decided improvement, healing edge, treatment repeated.

February 1st.—Ulcer covered with thin scab; no ionic treatment.

February 11th.—Ulcer healed; anterior splint removed. Patient left to report himself at his depôt.

Case 2.—A. W., cable-hand, æt. 30, attended the Electrical Department at St. Bartholomew's Hospital on March 22nd, 1915. Previous history:—While at work six weeks ago received two cable-burns, one on his upper arm, one on his thumb; treated by panel doctor, but refused to heal.

Condition on admission. Ulcer, $3\frac{1}{2}$ by $1\frac{3}{4}$ inches superficial, on back of right upper arm, over triceps; purulent base, many granulations, no pain. Thumb very swollen, most of skin ulcerated away, purulent discharge; pain only during last few days. Treatment: Thumb immersed in a small basin containing 1 per cent. solution of sulphate of zinc in which an electrode was submerged. This was connected with the positive pole. Four layers of lint soaked in a solution of 1 per cent. each of iodine and potassium iodide were applied to the burn on the upper arm. Over this was placed a small felt-faced brass electrode previously soaked in the same solution; this was bandaged on and connected with the negative pole.

March 25th.—Treatment repeated.

March 29th.—Ulcer on thumb fast healing, ulcer on arm measures $2\frac{1}{2}$ by $1\frac{3}{8}$ inches—very little pus, treatment repeated.

April 5th.—Treatment repeated.

April 12th.—Treatment repeated, ulcer on thumb healing satisfactorily; ulcer on arm, healthy granulations—$2\frac{1}{4}$ by $1\frac{3}{8}$ inches (maximum diameter).

April 19th.—Ulcer on arm $2\frac{1}{4}$ by $1\frac{1}{4}$ inches (maximum diameter), thumb still much swollen but rapidly skinning over, no pain in either ulcer. Treatment repeated.

May 20th.—Patient reappeared, both ulcers completely skinned over. Patient said they had healed up about a fortnight after last treatment.

June 21st.—Patient returned to report progress—both ulcers soundly healed. Patient wished to return to work and has not attended Electrical Department since this date.

One cannot draw many definite conclusions from the successful result in only two cases, but, from my own experience of the almost invariably favourable result in other cases of ulcers, callous and septic, it appears to me that ionic medication is clearly indicated in electric cable burns. As the two above recorded are the only cases of electric cable-burns which I have treated at St. Bartholomew's, I do not lay myself open to the charge of recording successes and withholding failures. In the Electrical Department of that hospital if ulcers fail to heal under zinc ionisation, the solution of iodine in potassium iodide is employed. This is actually in point of fact not a simple solution of iodine and potassium iodide; inasmuch as a chemical compound is formed, probably, as Dr. Cumberbatch suggests, a tri-iodide. If this fail the salicylic ion is employed, and so far I have come across very few ulcers, unless lupoid or malignant, which have failed to respond to one or other of these three ions.

I have had no experience of the effect of copper ions *per se* on ulcers, although, inasmuch as in Case 2 a brass electrode was submerged in the solution of sulphate of zinc in which the thumb was placed, there was probably an admixture of copper and zinc ions.

The rapidity of the healing process in the case of J. K. was commented upon by two eminent members of the staff of another hospital who visited the Electrical Department at St. Bartholomew's while the patient was under treatment. Case 2 was one which came under the Workmen's Compensation Act, and "compensitis" is a factor which does not usually conduce to the rapid cure of any lesion.

In cases of burns and ulcers under the most favourable surgical conditions, epithelium, according to some competent authorities, can hardly be made to grow at a faster rate than one-eighth of an inch a week. We therefore appear to have in ionisation a reliable method of speeding up the healing process.

I am indebted to Dr. E. P. Cumberbatch, Medical Officer in charge of the Electrical Department, St. Bartholomew's Hospital, for kind permission to publish the records of these two cases.

LOCATION OF FOREIGN BODIES.

By Edward M. Smiles, Roentgenologist.

American Hospital Service, Paris.

The following description covers, I think fully, the method I have used for locating foreign bodies absolutely with the X-ray, where apparatus that is specially designed for this purpose is not available.

It makes no difference where the foreign body is situated, it requires but three measurements to be made by the radiographer, there are no calculations whatever, and the surgeon simply follows the directions pasted on the radiograph.

Any carpenter can make the necessary equipment which consists of:—

1. A square wooden frame about 5 mm. thick, large enough to surround the largest photographic plate used. Two thin wires are placed in the frame at right angles to one another so that they cross at the centre.

2. Two wooden rods, about 1 cm. square and about 65 cm. long. These are pointed at one end, and split about 5 cm. down the centre at the other. At

the pointed ends strong threads are attached. These should be about 1 metre long.

3. A square lead block, about 15 mm. square and 2 mm. thick, with a hole in the middle, and a small lead plummet on a thread to centre the anode focus of the tube.

Modus Operandi.

The first thing necessary is to get a general idea of the location of the foreign body with the fluoroscope. Coat the wires of the frame with red ink. Place a radiographic plate on the table and lay the frame over it so that the edges of the plate are parallel and square with the frame.

Lay the patient over the plate, so that the region of the body containing the foreign body is as near the centre of the plate as possible.

Mark the skin of the patient in two places, about 15 cm. apart, in the region of the foreign body and in a line with one of the cross wires of the frame.

Place the X-ray tube at 60 cm. above the plate and with the supporting arm horizontal and parallel with the two marks on the patient and the cross wire of the frame.

Drop the plumb line from the anode focus to the centre of the lead block, which you have previously placed on one of the marks on the patient's body, so that the mark can be seen through the hole in the block.

Make an exposure, and then make another exposure by placing the lead block over the other mark, and then proceeding as in the first instance.

When you develop this plate you will find two pictures of the lead block, two pictures of the foreign body, and a double picture of the region of the body with the wires crossing it.

Place the plate upon the table, and arrange the tube stand so that the arm is in the same position with regard to the crossed wires as it was when you took the radiograph, also that the top edge of the arm is 60 cm. from the plate.

Rest the upper ends of the wooden rods at points on the arm vertically over the centres of the pictures of the lead blocks.

Place the points of the rods each in one of the pictures of the foreign body.

Cross the threads, and slip the ends through the split ends of the opposite rods.

Adjust these threads so that they will leave the upper ends of the sticks at points corresponding with the two positions of the anode focus when taking the pictures.

The point where the threads cross is the absolute location of the foreign body.

The distance of this point vertically from the plate is the distance of the foreign body from the skin of the patient; and its distance from the crossed wires can be easily measured on the patient's skin as he is marked identically the same as the radiograph.

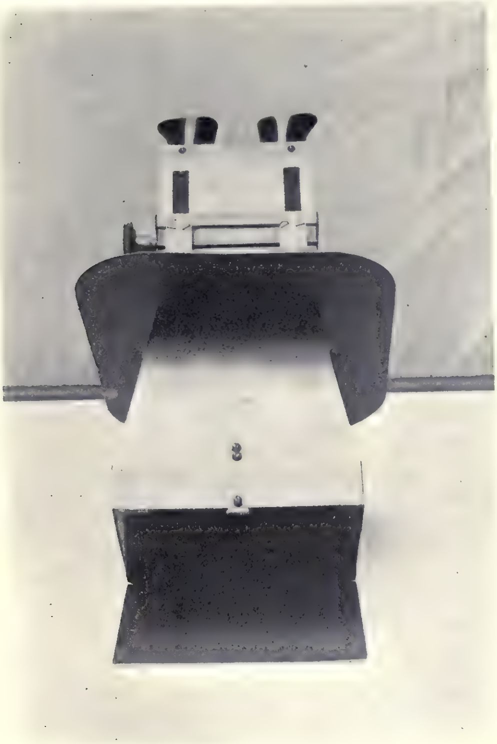
The radiographic plate is sent to the surgeon with a card pasted in the corner giving the necessary measurements.

NEW INSTRUMENTS.

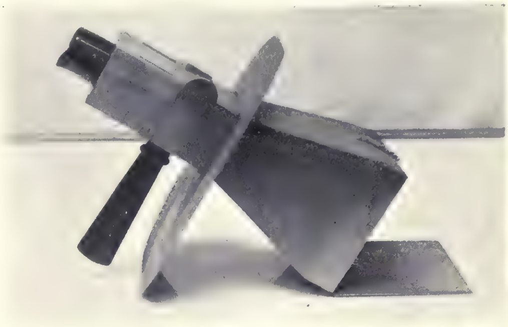
AN ASEPTIC CRYPTO-FLUOROSCOPE FOR USE IN THE OPERATING THEATRE.

By William Mitchell, M.B.,
Hon. Physician-in-Charge Electrical Dept.,
Royal Infirmary, Bradford.

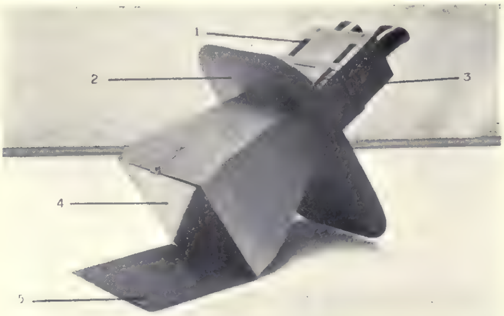
The following instrument, would, I think, prove a useful adjunct to many of our military hospitals. There is, of course, nothing new in a fluoroscope for use outside the dark radioscopic room, but all I have seen have been large and cumbersome and incapable of being sterilised. This instrument, which is all nickel-plated metal, except the enclosed platino-cyanide of barium screen, can be put in a steriliser and boiled along with other instruments, the fluoroscopic screen being removed during the sterilising process, and afterwards shut up in its interior by aluminium door (5) shown in illustration. There is a rack and pinion which operates a draw tube (3), so as to give telescopic adjustment of the eye pieces for myopic or presbyopic vision. This instrument was originally designed by me for the use of surgeons operating for the removal of renal calculi. I had observed that it occasionally happened that branching calculi had to be broken up in removal, and that fragments were not unfrequently left in the apices of the renal calices without being detected by the surgeon's fingers or by needling. With this instrument and an X-ray tube in the operating theatre (not necessarily close at hand) the kidney readily can be examined, while supported in the lumbar wound, by means of a celluloid plate with a notch in it to slip the pedicle through, and thus the danger of replacing a kidney with a calculus or calculi not completely removed can be obviated on the spot and at the time of operation. With an X-ray tube under an aluminium topped, or wooden, operating table it is obvious that this



With fluoroscopic screen removed prior to sterilisation.

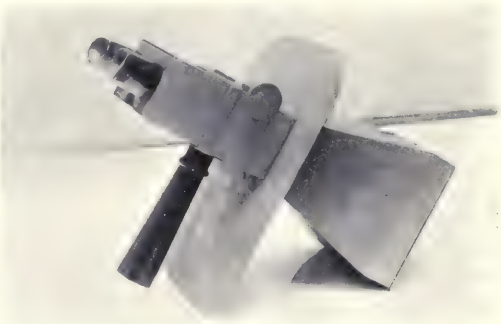


Scale roughly ⅐ actual size.



1. Ratchet for operating extension draw tube.
2. Metal shield for operator's face and hands.
3. Draw tube with eye pieces on end, nearly fully extended.
4. Fluoroscopic screen (removable) backed with lead glass to protect operator's eyes.
5. Aluminium door for shutting up fluoroscope.

would be a useful instrument in aiding in the removal of metallic foreign bodies in military hospitals, for no matter how carefully the depth and position of a foreign body is estimated radiographically, it is of comparatively little help if that body is situated in a movable organ, or in one that may readily be pushed on one side during operation. With this instrument the surgeon or his assistant can see, radiographically speaking, the foreign body at the time of removal. If newspaper reports are to be relied upon an instrument probably of this description is already in use in military hospitals in France and Switzerland. This fluoroscope was made for me by Mr. A. E. Dean, of London, two years ago, and I am indebted to him for the careful manner in which he carried out my suggestions.



NOTES AND ABSTRACTS.

Operative Findings in Twelve Cases of Chronic Intestinal Stasis.—Bainbridge, W. S., *Tr. Am. Ass. Obst. & Gynec.*, Buffalo, 1914, Sept. By Surg., Gynec. & Obst.—The one important part of the output of grist from the mill of controversy and discussion which had been built up around the theories of Sir W. Arbuthnot Lane concerning chronic intestinal stasis was the establishment of the facts of the existence of the adventitious intra-abdominal structures, "evolutionary bands," and of the condition of stasis which they cause. Around these two facts has developed some very creditable work by different investigators, but there still remain certain questions to be settled.

It is important to study the human digestive canal as a great drainage system, and to consider this system as a whole, remembering that defects in one or more parts are apt to derange the entire plant.

The author presented a series of cases as illustrations of the following points:

1. The possibility of making the diagnosis of chronic intestinal stasis by clinical examination alone, without the aid of X-ray or fluoroscopic study.

2. The verification of the diagnosis by the discovery, at operation, of the bands and the kinks.

3. The discovery, in certain instances, of conditions which may be interpreted as corroborative evidence of the correctness of Lane's theory regarding the possible remote effects of chronic intestinal stasis.

Opaque Meal Shadows in Diseases of the Stomach.—J. Alfred Codd, *Practitioner*, August, 1915.—The chief conclusions reached by the author are:—

1. Excessive motility may be defined as the picture seen when a wave passes along a shadow and cuts into it for a distance of half its depth or more; when a wave passes along from one end to the other in ten seconds or less; and when the long axis of the shadow moves through a considerable angular distance or executes vermicular movements.

2. If the stomach shows excessive motility immediately on the reception of the meal, or in four hours, and the stomach is clear in six or eight hours, there is probably peptic ulcer.

3. If there is no excessive motility immediately, but it shows itself in four hours, and the stomach is not empty in eight hours, there is probably pyloric obstruction, especially if there is excessive motility in eight hours, as well as in twenty-four hours, in an unemptied stomach.

4. The hour-glass shape is fairly typical,

and should show a definite neck or isthmus. If there is a mere constriction, with both sacs in contact, it is probably spasmodic, and should be watched for signs of change.

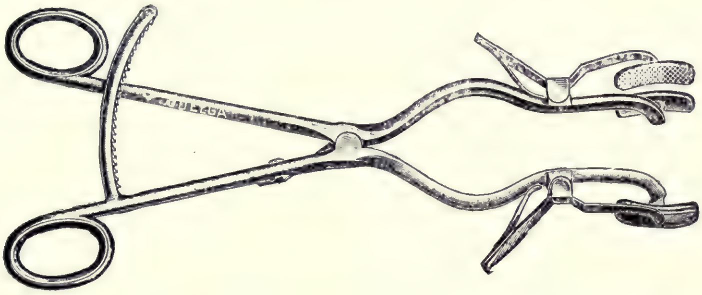
5. If Barclay's duodenal sign is present, there is probably ulcer of the duodenum, either a "surgical" one or a surface abrasion, impalpable from the outside.

ENQUIRY COLUMN.

W. H. S.—"In response to your courteous invitation to enquirers, I shall be much obliged if you will give us a sketch and specification of the instrument mentioned by Dr. Leopold Freund, in the ARCHIVES of February last, p. 334, for treatment of affections of the vulva, as I think it must be extremely useful. Or perhaps you can inform us where in London the instrument can be procured. It is not possible out here to refer to Dr. Freund's original article.

"Some of us out here would be grateful to you for some account of the work being done with the Coolidge tube."

We reproduce below the figure which illustrates the article to which W. H. S. refers. No more details of its construction appear in the original than were given in the ARCHIVES February number, but there would appear to be no difficulty in making the instrument from the specifications given.



With regard to the enquiry concerning the Coolidge tube, arrangements are in progeess whereby readers of the ARCHIVES will have the benefit of some original articles on the subject of the radiation from this new X-ray tube.

ERRATUM.

In the September number, the first paragraph on page 134 should conclude with inverted commas.

CORRESPONDENCE.

33, Cavendish Square, W.,
Aug. 21st, 1915.

To the Editors of ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY.

SIRS,—With reference to the remarks on X-ray localization (in your August issue) by Dr. N. K. Cherrill, may I point out that "a brass ring on the end of a thin lath of wood" is the device which I described in November last under the name of a "Ring Localizer." I soon abandoned this primitive form, however, as it could not be sterilized. Surgical cleanliness in localizing instruments is essential in military radiography. This sterilizable instrument has been on the market since the beginning of the year, together with a similar device having a pneumatic attachment, which enables an adhesive wafer to be attached *underneath* the body.

I may add that my mechanical wall diagram enables *any* base line up to seven inches to be employed, and gives a direct reading of depth without the use of any scale or calculations whatever.

The instruments above referred to are made by Messrs. W. Watson and Sons, 196, Great Portland Street, W., and their mode of employment is described in the author's pamphlet on "The Localization of Bullets and Shell Fragments" (H. K. Lewis, 1s. net).

Yours faithfully,
F. HERNAMAN-JOHNSON.

The Editors of the ARCHIVES OF THE ROENTGEN RAY.

DEAR SIRS,—I wish to express my sympathy for Dr. Deane Butcher's illness, and regrets that it should have compelled him to resign the editorship, which he has conducted so ably; and I beg to congratulate the readers of the ARCHIVES on the board of distinguished scientists who have been good enough to accept the position.

I am, Gentlemen,
Yours respectfully,
W. H. SYMES.

63, Worcester Street,
Christchurch, N.Z.

June 24, 1915.

NOTICES.

ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY is published monthly.

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All contributions to the Journal should reach the Editors by the 7th of the month.

Communications and illustrations from American contributors may be sent to Messrs. Rebman Company, 141-145, West Thirty-sixth Street, New York City.

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Contributors of original articles, whether illustrated or not, will be furnished with 50 reprints free of cost. All radiographs and photographs must be originals, and must not have been previously published.

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Annual Subscriptions, payable in advance, to members of recognised medical and scientific societies, 16/-, to non-members, 21/-, including postage. Single copies 2/- (postage 2d.) Single numbers and back numbers can be supplied on application.

Vol. XX—No. 6 NOVEMBER, 1915 No. 184

ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

Editors.

ROBERT KNOX, M.D., Hon. Radiographer, King's College Hospital.
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SIDNEY RUSS, D.Sc., Physicist to the Middlesex Hospital.

IN COLLABORATION WITH

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EDITORIAL.

The need for a list of qualified men engaged in the practice of Radiography, Radiotherapy and Electrotherapeutics has on several occasions been brought to our notice. That this list would be of the greatest value to those engaged in active practice is beyond doubt. In order to be useful the list must be comprehensive, so that a medical man who sends a patient to a distant town may be able to communicate with a colleague who is competent to carry out the particular treatment recommended. In order to, as far as possible, meet the demand, we have arranged for a leaflet to be issued with the current number of the Archives. We invite our readers to fill in the required particulars and send it on to the publisher. The list when completed will be published in the Archives, and at a later date issued as a pamphlet or included in a year book—whichever is most expedient.

The object of the list is to furnish in as small a space as possible a complete guide for the use of the profession, so we trust that our readers will condense the subject matter as much as possible.

A NEW THERAPEUTIC X-RAY LOCALISER.

By Robert Knox, M.D., and A. St. George Caulfeild.

This apparatus has been elaborated from experimental work done in the Radio-Therapeutic Department of the Cancer Hospital. It is hoped that it will prove to be of great use to the radiotherapist both in focussing a maximum of rays on a particular point and in the accurate estimation of the dose given.

The great aim of the radiologist is the perfection of the technique of his art. Recently a great advance in tube constuction has given us the Coolidge tube, and there can be no doubt that this tube has greatly increased our range of therapeutic action.

The modern X-ray generators have placed in our hands apparatus capable of stimulating the most modern tube, and the fine adjustment of the latter enables us to vary the hardness and penetration of the ray. These improvements in apparatus are of great value, but if we are to utilize them to the full we must have more accurate accessory apparatus in the shape of tube stands. The more modern tube stands are constructed on sound principles, but their sphere of usefulness is nevertheless limited—in superficial therapy they are of great use, but when we attempt deep therapy we are greatly handicapped. The various attempts made to overcome this difficulty have been real steps in advance—the elaboration of the technique for the treatment of fibroids is a striking instance—in most of these cases the tube box is fixed but is capable of several adjustments to meet the needs of particular cases. The moving tube has been attempted on several occasions and complicated apparatus devised to attain this object. From suggestions and observations on this form of apparatus, we were led to apply the principle of the moving tube to the treatment of deep-seated diseases. The aim of the radiologist has been to direct the X rays into the interior of the body and to produce a maximum effect below the surface, while the skin area over the tumour receives the minimum dose. The most complicated technique is that produced at Freiburg, where the skin surface is divided into a number of areas, each area receiving a definite dose, the aim being to produce a maximum effect upon deep-lying structures.

The employment of X rays for the localization of foreign bodies directed our thoughts to the practicability of employing the central ray of the focus tube in therapeutics, the object being to direct the ray to a definite spot in the interior of the body. The principles employed in localization are quite applicable to the perfection of a technique for therapy, and rules found to be of value in the former are equally applicable to the latter.

The central ray is ascertained, the tube fixed to the stand, and by mechanical adjustments the rays may be projected into the interior of the body with an accuracy which is as surprising as its projection is simple. Moreover, the rays can be centred at any point and at any depth from the surface.

The principle employed is that of the rotating tube, making a circle upon the surface and focussing the sheaf of rays upon a point in the interior whose depth is determined by the angle at which the tube box is fixed.

Mechanical Details of the Apparatus.—The machine consists of a vertical bar, with a bar B bolted horizontally across its lower end forming an inverted **⊥**. This **⊥** is slung by a hook from the ball bearing C, through which passes the shank of the eye into which the hook fits. The shank carries the pulley D, which is rotated by a belt from the clock E.

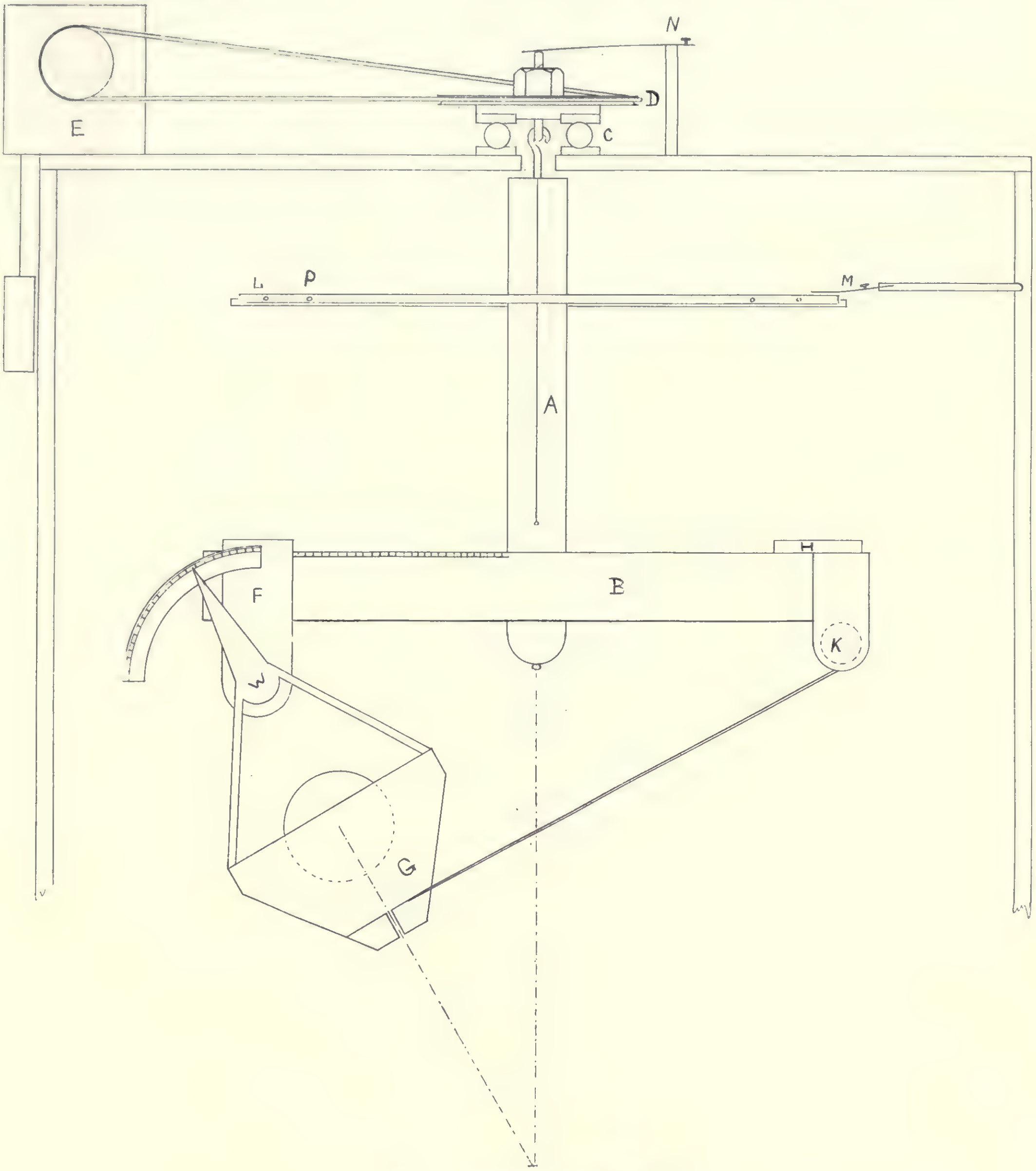

FIG. 1.—Mechanical Details.

A carrier F slides along one end of the arm B. This carrier carries the tube box G slung from the axis W.

A weight H slides along the other end of arm B in order to balance the weight of the tube box at any angle or distance from the centre A.

A winch K raises or lowers the tube box.

The carrier F has a scale of degrees showing the angle to which G is tilted. The bar B is scaled to show the distance the axis W is from the centre A.

An insulated brass circle L is carried on the bar A, and serves to collect the high tension current from the spring M, which is attached to the frame of the apparatus. When using a Coolidge tube another brass circle is fitted at P.

L is connected to one end of the tube. The other high tension terminal is at N, a spring which makes contact with the shank of the main eye bolt which is connected electrically to the other end of the tube.

An apparatus for finding the direction of the ray is provided, with equivalent scales, to enable the main apparatus to be set to any required angle.

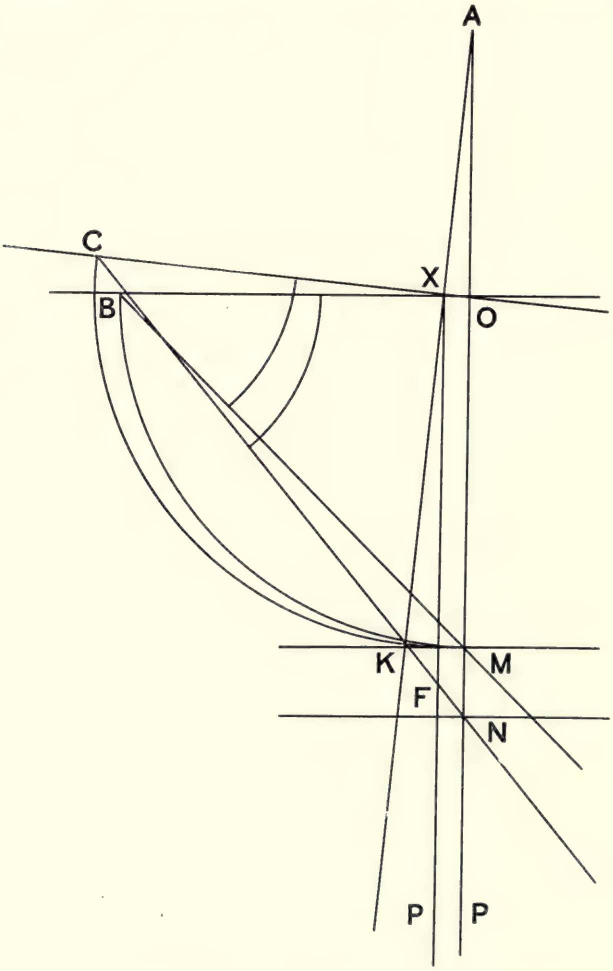

Fig. 2.—Diagram to illustrate Vertical Error.

Vertical Error.—Let AO be the vertical arm—OP the plumb line.

If AO is not vertical it will assume position AX.

The horizontal bar will then be at XC.

The tube box is at a constant angle, 45.

If AOP is vertical the pencil of rays BM will strike at M. When AXC is the position of the bar the same pencil of rays will strike the plumb line which now hangs from X at point F, and the position of the ray on a skin plate at KM will be K instead of M. Circles on the skin plate would be larger than estimated by the length KM (as estimated on the drawing). Focus points would be deeper by the length MN.

Angular Error.—Suppose the setting of the tube to have a constant angular error, CTA. At a flat angle the focus point would be C instead of A. At a steep angle the focus point would be D instead of B.

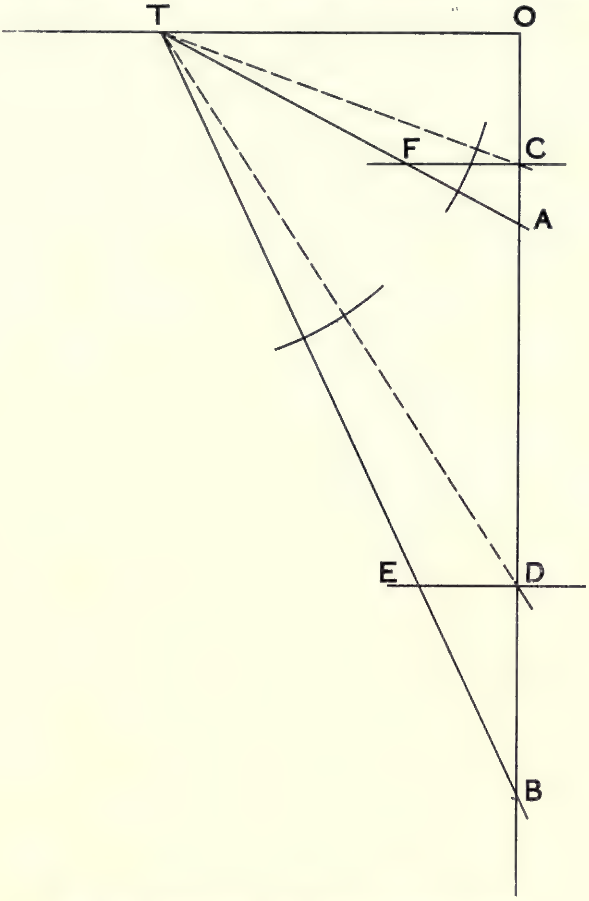

FIG. 3.—Diagram to illustrate Angular Error.

A skin circle would be less in radius by the length FC, and in a steep position by the length ED.

The flatter the angle the less the vertical error and the greater the horizontal error.

Error in Scale Adjustments.—There can be an error in reading the angular scales on the apparatus in its present rough form of nearly 1°.

The tube box cannot be adjusted to a greater accuracy than $\frac{1}{2}$°.

If these two errors are additive there would be a total angular difference of $1\frac{1}{2}$°, *i.e.*, with a focus point adjusted at 35″ below the horizontal, the actual focus point might be at $36\frac{1}{2}$″, the angle of the tube being $28\frac{1}{2}$ instead of 30.

A skin plate at 30″ below the horizontal would have its circle $\frac{3}{4}$″ larger or smaller than the estimate.

The tube is set at an angle of $32\frac{1}{2}$°, the skin surface is $14\frac{1}{2}$ inches from the anticathode, the focus point is at $26\frac{1}{2}$ inches from the anticathode. Fig. 4 represents photographic records taken with this setting, and shows three surface circles, with the rays converging to the same focus on a plate underneath and at right angles to the surface plate. The plates remained in the same position during the three exposures.

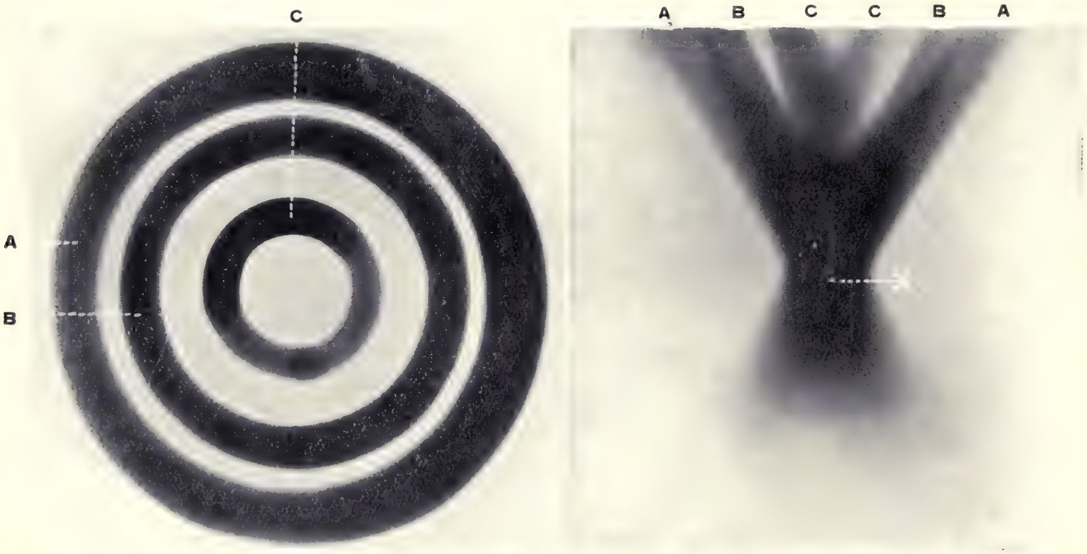

FIG. 4.

In another experiment the anticathode was set at $13\frac{1}{2}$ inches from the skin—the plate representing the tumour to be treated was 19 inches from the anticathode, this being the area of maximum irradiation, the size of the circle being $5\frac{1}{2}$ inches mean diameter. It was found that the tumour plate received a dose of 151 X, while any measured portion of the skin plate received 12 X. The total time taken to procure the 151 X was 192 minutes. The relative proportion of tumour dose to skin dose was 12.5 to one. The dose was given from a moderately soft tube and no filters were used.

The actual time taken to produce these results will be greatly shortened when harder tubes are used and larger outputs from the transformer utilized, but it is reasonable to expect that the relative proportions of dosage indicated will be maintained.

The description fully explains the mechanical features of the apparatus. These are capable of several improvements which will be added as experience in its use teaches their necessity. The advantages claimed for this Therapeutic Localiser are:—(1) Accuracy of application. (2) The possibility of repeating at subsequent exposures the dose primarily given. (3) The radiations can be varied in depth and latitude in order to influence all portions of a growth. If desired, the focus point can be fixed in front of, or behind, or at the centre of the growth. (4) By changing the size of the circle two or more doses can be directed to the centre of the growth. (See Fig. 4 and 5). A centrally situated growth can be approached from all aspects of the body and the maximum dose administered on a point selected beforehand. Thus, a tumour of the mediastinum may be treated from four aspects with accuracy, at any depth from the skin surface.

By changing the focus point the whole area of the tumour can be irradiated to the necessary extent, the surrounding tissues receiving also an estimated dose.

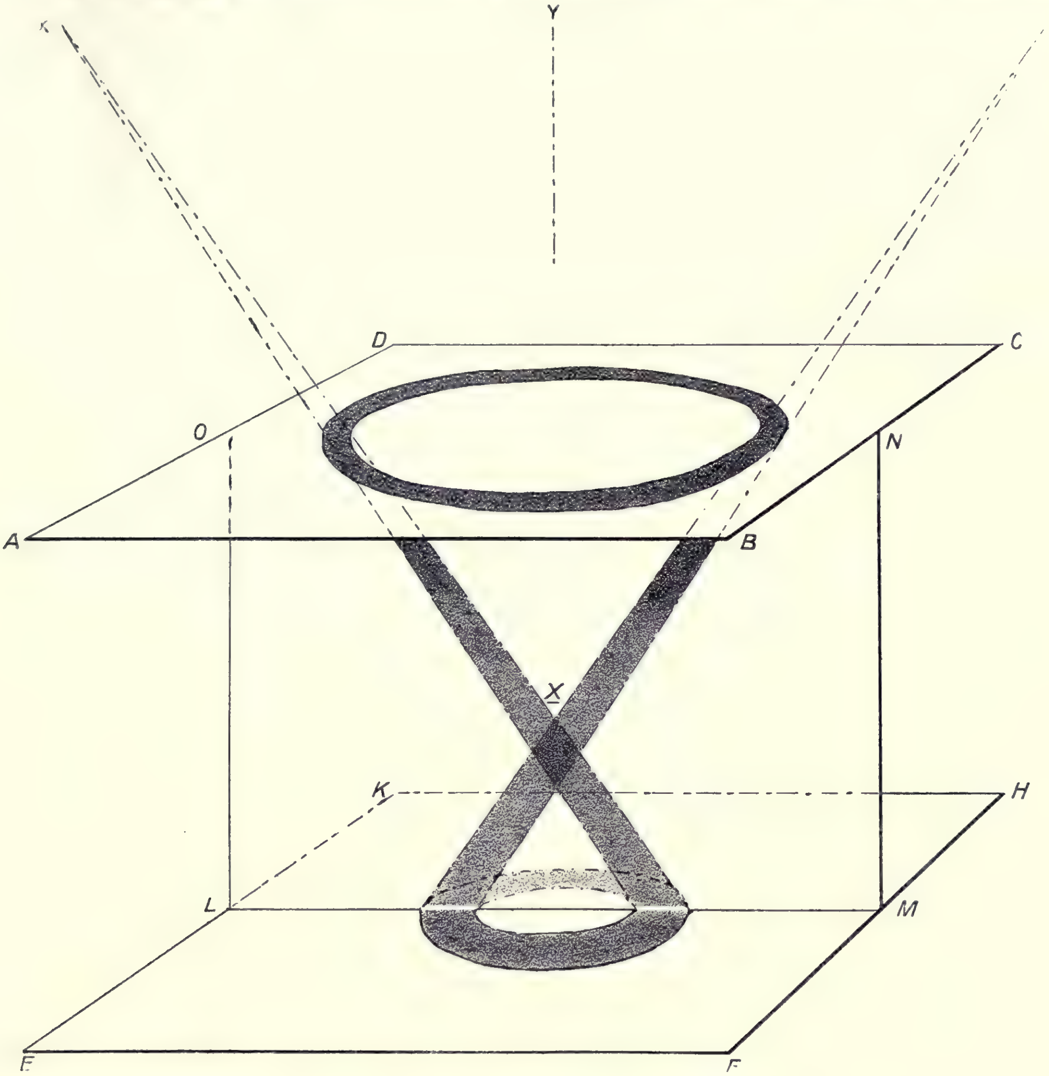

FIG. 5.—To show Method of Placing Plates.

Let A B C D, E F H K be two parallel planes and L M N O a plane vertical to them.
Let the centre of rotation Y pass through the plane L M N O.
Let X be any pencil of rays proceeding from an anticathode X. The tube being fixed at a constant angle to, and rotating round the centre of, rotation Y.
Then the rotating ray X will describe the circle shown on the plane A B C D. The rays from opposite points in the circle of rotation will converge at X and diverge beyond it to describe the circle drawn on the plane E F H K.

By this method it is also approximately possible to estimate the dosage received by the tumour. The dose on the skin is estimated in the usual way, by pastille or paper, and the total dose received by the tumour is calculated by allowing for the absorption of the rays by the tissues and the absorption by distance.

The objects aimed at by the established technique, namely, protection of the skin area with the maximum irradiation of the deep parts, are obtained by the use of this apparatus with none of the attendant disadvantages. It is unnecessary to protect the surrounding skin with heavy lead rubber, consequently fatigue of the patient is obviated. The accuracy of the localization will render it possible to obtain therapeutic results with much smaller doses.

The tube box can be adjusted to irradiate a large area of skin surface by changing the angle ; and by using a larger diaphragm the advantages of an ordinary tube box are easily obtained. While using the apparatus for deep therapy the ordinary filters are inserted between the tube and the skin surface, while the secondary filters are applied to the skin surface.

The new apparatus will find its largest field of usefulness in the treatment of deep seated diseases. Fibromyomata uteri, deep seated cancers of the breast, cancer of the uterus, mediastinum, and other new growths, and also for the irradiation of the spleen and long bones in diseases of the blood.

The technique for the treatment of fibromyomata is greatly modified. Three points are selected, namely, the ovaries right and left, and the tumour in the uterus. The maximum dose is administered to each ovary with great accuracy, provided the position of the ovary can be located, then it is only a matter of calculation to centre the rays on the organ. It is possible that with the greater accuracy of dosage the necessary time may be greatly shortened. With experience in the use of the new apparatus it may be possible to produce effects with one or two administrations instead of the four or five now required.

Enlargement of the prostate gland may be treated from two aspects, (*a*) the supra pubic, (*b*) the perineal.

In each case the rays are centred upon the enlarged gland and a full dose given. It may, however, be necessary to protect organs in the direct line of the rays. This can readily be done by covering any part of the circle with a piece of lead rubber or similar material.

The chief field of action for the centring device will be in the treatment of malignant disease. It will be possible to attack a growth from all aspects and the maximum dose be administered at will to selected areas of the growth. Given suitable tubes of great penetrative power it should be possible to produce effects similar to those obtained when a radium tube is buried in the substance of a growth. It is not intended to suggest that X rays should take the place of radium ; both are useful, and the one may be used to supplement the other. There are, however, many cases of new growth where it is impossible to place a radium tube in the substance of the growth, and where radiations from the skin surface, obtained from radium alone, are quite ineffectual. In these cases the X rays may be projected into the new growth from several aspects, the tumour receiving a dose of sufficient activity to produce therapeutic effects. The new method will enable us to reach tumours in any part of the body.

Thus, tumours of the mediastinum, œsophagus, liver, stomach, and other abdominal organs, will all be reached by the central ray when carefully focussed upon them.

Experience in the use of this apparatus, with a full knowledge of the dosage, will enable us to accurately establish a technique applicable to any condition requiring treatment.

The possibility of accurately locating the maximum effect of the radiations will open up greatly increased fields of activity in radiotherapeutics, and will mark a real step forward in technique, and enhance the value of X rays.

The new apparatus may be adapted for the application of radiations from radium when used from the surface. A lighter machine constructed on the same principle will enable us to irradiate a tumour in the same way. X rays and radium rays may thus be used in the same case. A thorough irradiation from the X-ray tube may be supplemented by a full dose from the gamma-ray of radium when we have reason to suppose that the latter will aid in the production of the desired therapeutic effect. By varying the type of ray we should be able to effect changes in a growth which might not be obtained by either alone.

No claim is made to the original idea of the rotating tube-stand. It is the result of observations and suggestions and experiments made in the Radio-Therapeutic Department of the Cancer Hospital, London. The Hon. Physicist, C. E. S. Phillips, has greatly aided in forwarding the scheme by his suggestions, and improvements have been suggested by several members of the Staff.

We do claim, however, to have placed in the hands of the radiotherapeutist an instrument of precision which should greatly aid in the application of X rays, and will undoubtedly lead to a great advance in our knowledge of dosage and therapeutic effect, and we hope to a considerable improvement in results.

THE PHOTOGRAPHIC ACTION OF RADIO-ACTIVE SOURCES.

By Walter Makower, M.A., D.Sc.,
Lecturer in Physics, Manchester University.

One of the most remarkable developments in radio-activity has been the light thrown upon atomic phenomena, which by radio-active methods can be investigated more intimately and directly than in almost any other way. Thus the α particles emitted by radio-active substances have been identified as charged atoms of helium travelling with enormous velocities, and their number has been directly counted by Rutherford and Geiger by an electrical method. Geiger and others have also counted the number of α particles emitted by radio-active sources by examining under the microscope a phosphorescent screen of zinc sulphide upon which the α rays impinged. The phosphorescence observed by the naked eye is thus found to consist of individual instantaneous flashes or " scintillations," each produced by the impact of a single α particle, the number of which can be directly counted. But not only can the presence of individual atoms of matter in the form of α particles be detected, but their complete paths through gases can be recorded and examined in detail by a most beautiful method devised by C. T. R. Wilson.(1) This consisted in causing a cloud to form on the ions produced along the path of an α particle and photographing the track of the cloud thus formed. Similar photographs could also be made with β and γ rays, and the differences between the properties of the various types of rays were strikingly demonstrated. There is, however, yet another way of recording and investigating the passage through matter of the radiation from radio-active bodies which has only recently been developed. This method consists in examining microscopically the photographic action of the radiations, and possesses the advantages of great simplicity and delicacy.

Although the discovery of the radio-activity of uranium was made by the photographic action of uranium salts as long ago as 1896, the nature of this effect was not studied in detail for many years. The first important investigation of the photographic action of α particles was made in 1910 by Kinoshita(2) who succeeded in showing that whenever an α particle strikes a grain of silver helide in a photographic plate, that grain is subsequently capable of photographic development; moreover, this was true throughout the range of the α particle. Later it was shown by Reinganum and others(3) that when α particles are projected tangentially to a photographic plate, after development the film shows definite trails of grains of silver helide which can readily be distinguished under the microscope. These trails are produced by the impact of the α particles on the helide grains as they pass through the film, and their length represents the range of the α particles in the film of gelatine. It is evident, therefore, that we are dealing with an extremely delicate method of detecting and studying the emission of α rays, for each single α particle produces a record of its passage through the photographic film, and the path taken by each particle can be studied in detail.

Microphotographs showing the paths of α particles through photographic films were first published by Walmsley and Makower(4) and soon afterwards by Kinoshita and Ikeuti.(5) The method adopted by the latter was to activate the tip of a sewing needle by gently rubbing it on a surface coated with the active deposit of radium or some other source of α radiation. In this way a trace of active matter was transferred to the point of the needle, which was then placed for a short time in contact with a photographic film. A microphotograph of an impression taken in this way, with radium C as source and with a magnification of 380 diameters, is shown in Fig. 1. The grains affected by the α particles can be clearly seen radiating out in straight lines from two centres representing the points at which the needle had been brought into contact with the films.

A defect of the method when applied to quantitative measurements is the difficulty of obtaining photographic plates capable of development without showing under the microscope a number of blackened grains, even when the plate has not been exposed to light or any radio-active source. For some reason most photographic plates, if developed without exposure to light or other stimulus, though showing no visible fogging to the naked eye, are found on examination under the microscope to be covered with blackened silver grains. It is, therefore, important to use a plate which, when suitably developed, is free from this defect. After a careful search it was found by Sahni ⁽⁶⁾ that this condition is best satisfied by Wratten and Wainwright's lantern plates, developed in complete darkness for 2½ minutes with the following developer, the solutions A and B being mixed in equal proportions :—

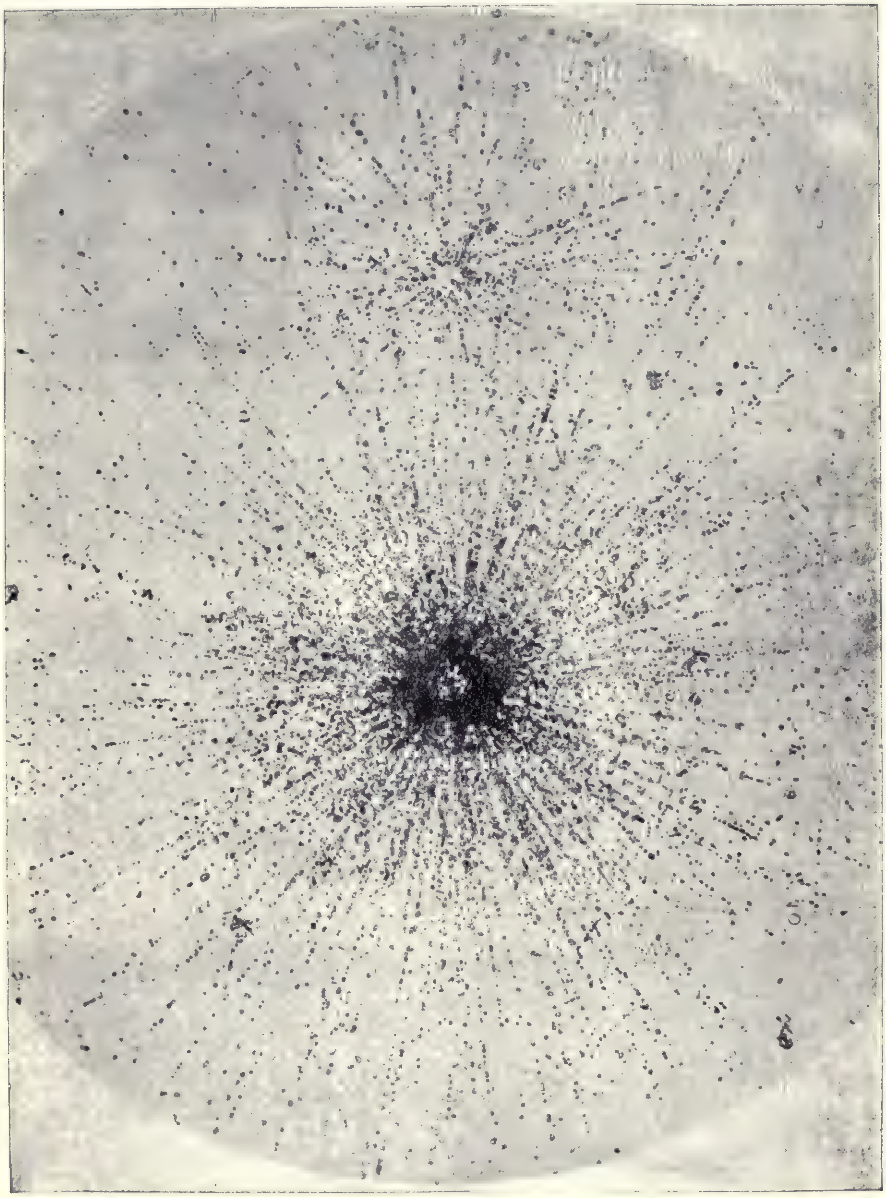

FIG. 1.

(By kind permission of the Philosophical Magazine.)

Solution A.

1. Quinol, 25 grams.
2. Potassium metabisulphate, 25 grams.
3. Potassium bromide, 25 grams.
4. Distilled water made up to 1,000 c.c

Solution B.

1. Caustic potash, 50 grams.
2. Distilled water made up to 1,000 c.c.

A record obtained with such a plate, and developed as described, is shown in Fig. 2. In this case a needle point made active with polonium was used and the original photograph is magnified 55 diameters.

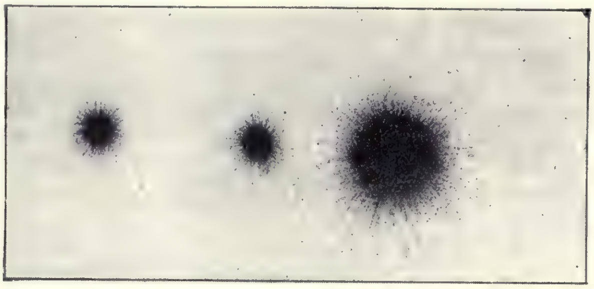

Fig. 2.
(By kind permission of the Philosophical Magazine.)

A careful study of the tracks made by *α* rays on passing through a photographic film reveals some interesting points. It is well known that although the majority of *α* particles pass in straight lines through matter, occasionally a particle is deflected or "scattered" from its path. This happens when the *α* particle, in traversing the absorbing material, passes so near to the nucleus of an atom that it is deflected from its path by the enormous electric field existing there. This effect, which is a well-known property of *α* particles, can be demonstrated by examining the tracks made by *α* particles in a photographic film; for whereas most of the tracks are straight, occasionally one is found with a sudden bend in it. Such a one magnified 1,650 diameters is reproduced in Fig. 3, from the paper of Walmsley and Makower, quoted above. It can be seen that in this case the *α* particle, which was emitted by radium C, has been suddenly deflected in the middle of its path. As predicted by theory

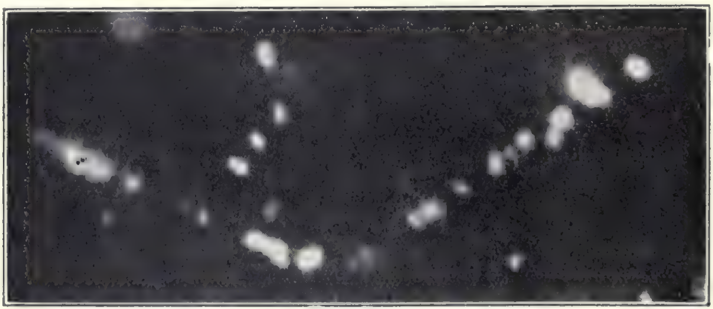

Fig. 3.
(By kind permission of the Council of the Physical Society.)

this phenomenon occurs only very occasionally, and it is therefore necessary to examine a large number of tracks before finding one which shows the effect. Moreover, as anticipated, the scattering is most often found to occur near the end of the range of an α particle.

The photographic action of β rays is less characteristic that than of α rays, and has not been studied in such detail. The scattering of β particles, when they pass through matter, is much more marked than with α particles, so that the β particles are scattered in all directions by the photographic film. Such definite tracks as with α particles could therefore hardly be expected, for a particle originally travelling in the plane of the film may be deflected out of that plane and so be lost to the photographic record. Besides, it is uncertain whether a single impact on a silver helide grain by a β particle is sufficient to render it capable of development. Nevertheless, microphotographs of films subjected to β rays are not without interest on account of the striking contrast which they present to α-ray photographs. A microphotograph taken by Sahni with β rays from radium E is shown in Fig. 4, the magnification being 50 diameters. It will be seen that the developed grains show no definite configurations, the record being indistinguishable from one made by exposing a plate to a weak source of light. As might be expected, photographs taken with γ rays are indistinguishable from β-ray photographs, for the photographic action of γ rays is due to the production of secondary β rays developed by the γ rays as they pass through matter.

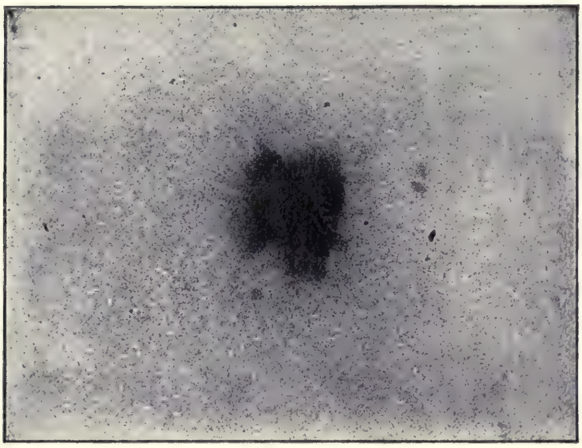

FIG. 4.

(By kind permission of the Philosophical Magazine.)

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(1) Proc. Roy. Soc. A 87,277, 1912.

(2) Proc. Roy. Soc. A 83, 432, 1910.

(3) Reinganum Phys. Zeitshr, 12, 1,076, 1911; Michl. Wien. Ber. 2 A. 1,431, 1912; Mayer Ann. d. Phys. 41, 5, 931, 1913.

(4) Walmsley and Makower, Proc. Phys. Soc. 26, 261, 1914.

(5) Kinoshita and Ikeuti, Phil Mag. 29, 420, 1915.

(6) Sahni, Phil Mag. 29, 836, 1915.

FLUORESCENT SCREEN LOCALISATION BY THE PARALLAX METHOD.

By **Alfred C. Jordan**, M.D. (Camb.), M.R.C.P.,
Hon. Radiologist, Hospitals for Officers, Fishmongers' Hall and Queen Alexandra's, Highgate.

Since the introduction of my simple little instrument (a development of the localiser introduced many years ago by Shenton), there have been numerous opportunities of testing its practical use and gauging its accuracy. Moreover, there have been chances of learning the views of those who have adopted my instrument for the routine localisation of bullets and fragments of shell. The object of the present communication is to draw attention to some practical points.

In the first place, only those will be able to use the instrument with success who have adopted a method of fluorescent screen observation similar to that used by myself. This method is due to no initiative of mine, its main features are due to my friend, Mr. Shenton ; hence, it is not surprising that I should have come to adopt—independently—a method of localisation almost identical with his.

The essentials of the method are:—

1. A couch with a tightly stretched canvas top (or a wooden top).

2. A thoroughly protective tube-box with an adjustable rectangular diaphragm and a convenient method of moving the tube-box in a horizontal plane in the longitudinal and tranverse direction of the couch. This movement of the tube-box is carried out repeatedly while the tube is excited ; hence the necessity for special protection.

3. It is absolutely essential to have an arrangement whereby the operator is able to control, by a touch of the foot, both the current through the X-ray apparatus and the light in the room. A double foot-switch enabling this to be done can be added to any installation.

4. Fluorescent screen work in war injuries involves frequent examinations at close quarters, and no tube-box is so completely protective as to absorb all X rays issuing from a tube actuated by a powerful generator : therefore, I consider it necessary for the operator to interpose a lead-lined screen between himself and the couch. The screen I use is of wood, lined on both faces with three-pound lead (*i.e.*, sheet lead weighing three pounds to the square foot). A lead-lined shelf projects from the top of the screen, and overhangs the near margin of the couch. This shelf protects the wrists and forearms, and is useful as a receptacle for gloves, pencils, etc. (Fig. 1.)

5. For the sake of completeness I would mention, as necessary adjuncts, a pair of efficient protective gloves and a pair of protective spectacles. The fluorescent screen must, of course, be covered with lead glass of good quality.

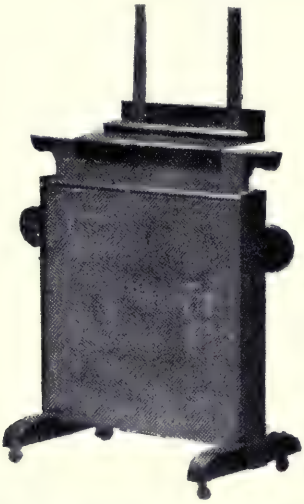

FIG. 1.—Author's lead-lined screen.

The localiser was made for me by Messrs. Watson, and has been described by them and by myself. Its construction is seen at once by the diagram (Fig. 2). The fluorescent screen is placed horizontally upon the part of the patient under examination. Each upright of the localiser has an adjustable clamp near its upper end. One or both of these is attached to the fluorescent screen so as to keep it in a horizontal plane, and if necessary take the weight of the screen off the patient. In many cases only one upright is used, the

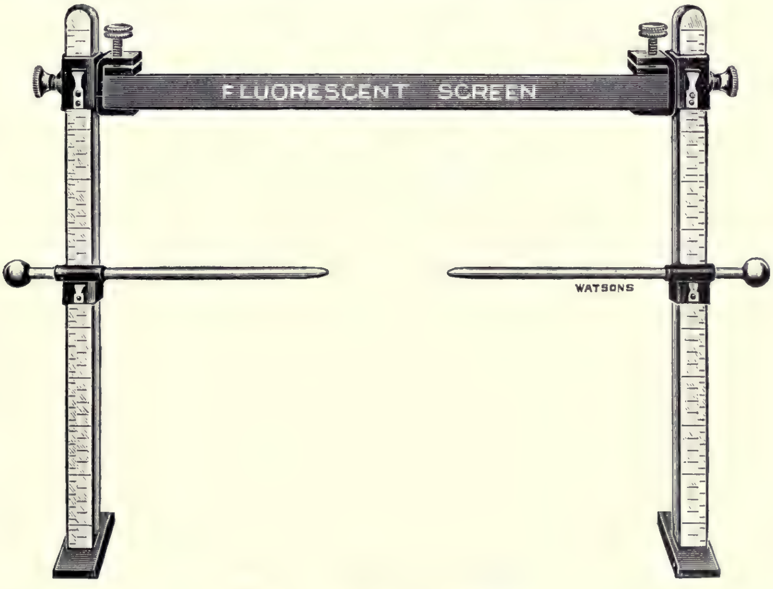

FIG. 2.—Author's Localiser.

opposite side of the screen being allowed to rest on the patient. The upright should, if possible, be on the side nearest the observer. The metal pointer is inserted into its sleeve (after all other adjustments have been made), and the tube is activated (the light being put out at the same moment by the foot-switch). The screen is so adjusted that the shadow of the pointer is in a straight line with the shadow of the foreign body. The direction of the shadows should be parallel with the side of the rectangular diaphragm of the tube-box. The size of the aperture is adjusted suitably ; a little experience will tell the best size. The tube (with its box) is now moved under the couch, and the corresponding movement of the shadows on the screen is observed. If the pointer and the foreign body are at the same depth below the screen, their shadows will move together, and will be in a straight line in all positions of the tube. If the foreign body is deeper than the pointer, its shadow will move more rapidly than that of the pointer ; if more superficial, its shadow will move less rapidly ; in either case the shadows will get out of the straight line. The pointer is thereupon made to slide up or down the upright as required, and the observation is repeated until, after a few trials, the two shadows (pointer and foreign body) remain in a straight line in all positions of the tube. The pointer is now indicating the exact depth, within the patient, of the foreign body. This depth is simply read off on the scale engraved on the upright of the localiser.

The second pointer is only used occasionally, in small parts (forearm or leg), where very great accuracy is required. The two pointers (see Fig. 2) must be moved up or down together through the same distance. The "clicker" enables this to be done readily, for one can feel each quarter inch as the pointer is moved along the upright. When the adjustment has been properly made the reading of the two sides is taken and compared ; the two readings should, of course, agree, and if the fluorescent screen has been accurately horizontal the readings will agree. The second pointer thus gives an extra means of checking the accuracy of one's observations.

To a careful worker, accustomed to fluorescent screen work, there should be no sources of inaccuracy provided the foreign body be easily visible with a moderate current ; otherwise the method is inapplicable. In military work there are few cases in which the foreign body is not readily seen ; the chief exceptions are small particles in the orbit and in the dense parts of the skull.

One of the greatest advantages of the fluorescent screen method of localisation is that it renders formal localisation unnecessary in a large proportion of cases. Many foreign bodies can be felt quite easily, and moved about under the screen, and their position marked at once on the surface of the body. In other cases the screen shows at once whether the foreign body is nearer the front or the back surface of the body or limb. In a recent case a rifle bullet had been localised in France to be six and a half inches behind a point marked on the front of the thorax. I saw at once, by the rapid rate of movement of the bullet's shadow on moving the tube-box, that the bullet was much nearer the posterior than the anterior aspect of the body. Accordingly, the patient was examined lying prone, and the bullet was felt at once as a hard lump in the spinal muscles. The bullet had gone right through the thorax. The localisation made in France was perfectly accurate, but did not give the surgeon the required information. Within the thorax the oblique and the lateral views often clear up the exact situation of a foreign body, and the movements accompanying respiration, the heart beat and the act of swallowing often show the position of the foreign body far more graphically than any method of formal localisation or of stereoscopic skiagraphy.

In many parts, notably the limbs, the position of a foreign body may be determined by the screen alone (without using a special apparatus), by examining in two planes at right angles, and making two marks on the skin, one in each plane. My apparatus enables the same two marks to be made on the patient's skin when he cannot be moved. The anterior mark is made in the usual manner. My localiser is then adjusted so that the pointer indicates the depth of the foreign body. The point is thrust in till it touches the skin. This is the spot for the required mark in the plane at right angles.

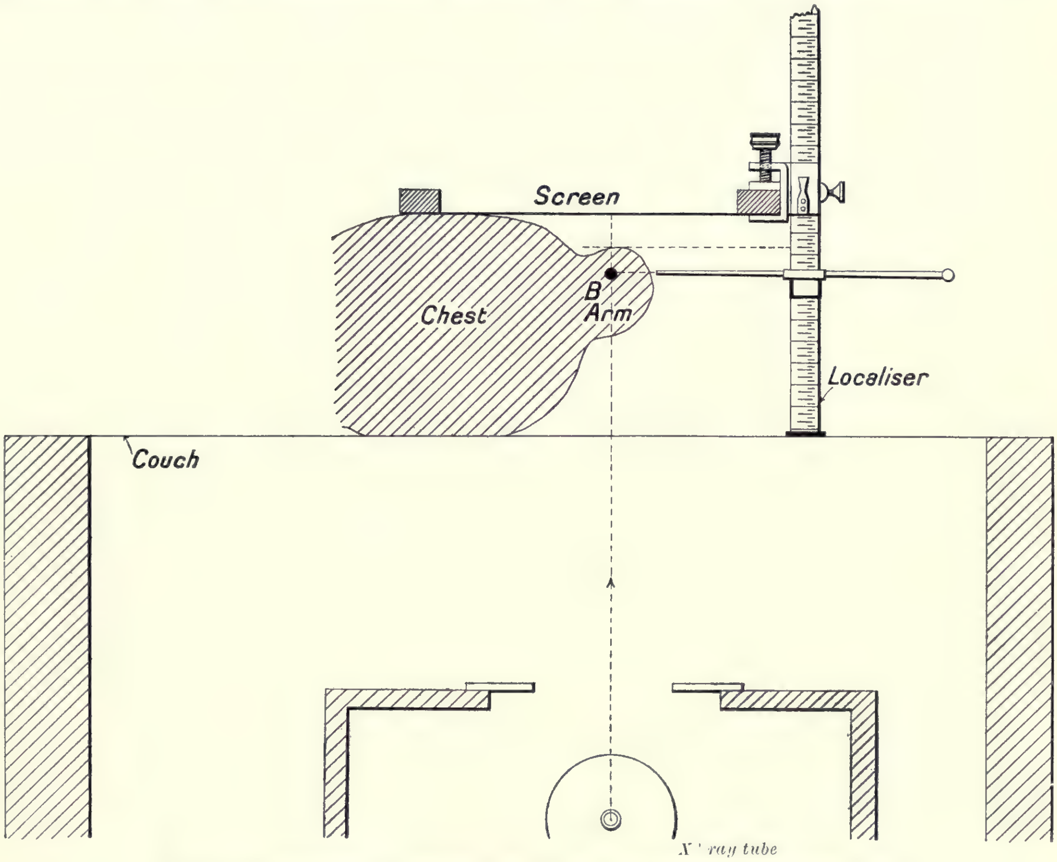

FIG. 3.—Localisation of foreign body in the shoulder. B—Foreign Body.

A bullet lying free in the abdominal cavity defies localisation, for its position is always changing. In one case a rifle bullet in the pelvis was found to have a range of movement of three inches, both laterally and from front to back, suggesting that the bullet was in the bladder. This was put to the test at once by asking the patient to empty the bladder. The range of movement was now found to be less than one inch in every direction. The diagnosis was confirmed by an examination with the cystoscope, and the bullet was removed from the bladder through a suprapubic incision.

There are parts of the body where a fluorescent screen of the usual size cannot be placed in contact with the skin—notably the shoulder and the neck. Here an apparent difficulty arises in applying the parallax method of localisation. In practice, however, the same method can be used. Take the shoulder, for instance, and suppose the patient lying on his back on the couch. His head is turned away from the injured shoulder, and the screen is allowed to rest by one margin on the chest (Fig. 3). The opposite margin of the screen is supported by the localiser so that the screen is horizontal. With a small opening the anterior mark is made in the usual way, the space between the skin and the screen making no difference. Then the depth of the foreign body below the screen is ascertained in the usual way by means of my localiser, and is marked on the outer side of the shoulder. Thus we get the position of the foreign body in two planes at right angles to one another. If we require the actual depth below the anterior surface of the shoulder we can read it off on the upright of the localiser by holding a small straight-edge horizontally in contact with the mark on the front of the shoulder.

Another method of obtaining this depth is to place a small metal object on the anterior spot, and to ascertain its depth below the screen by means of the localiser. The depth of the foreign body from the skin is then obtained by subtraction.

In conclusion, my experience leads me to believe that there are very few cases in which the localisation of foreign bodies cannot be carried out accurately and quickly by the parallax method, with the fluorescent screen alone, while further, the screen examination renders formal localisation unnecessary in many cases.

A FEW RADIOGRAMS TO ILLUSTRATE THE VELOCITY OF THE RIFLE BULLET AS THE DETERMINING FACTOR IN THE EXTENT OF AN INJURY.

By Geo. Vilvandre., M.R.C.S. (Eng.), L.R.C.P. (Lond.),
Late H.P. & H.S. Poplar Hospital for Accidents. Radiologist to a General Hospital, British Expeditionary Force, France.

The first radiograph shows the little harm a bullet may cause. The missile lodged in the infra-spinatus muscle, and after being localized with Barclay's instrument was easily removed, the patient being little the worse for his wound.

The second case is, I think, interesting because, although the bullet partly penetrated the lower end of the tibia, there followed no complete fracture, and

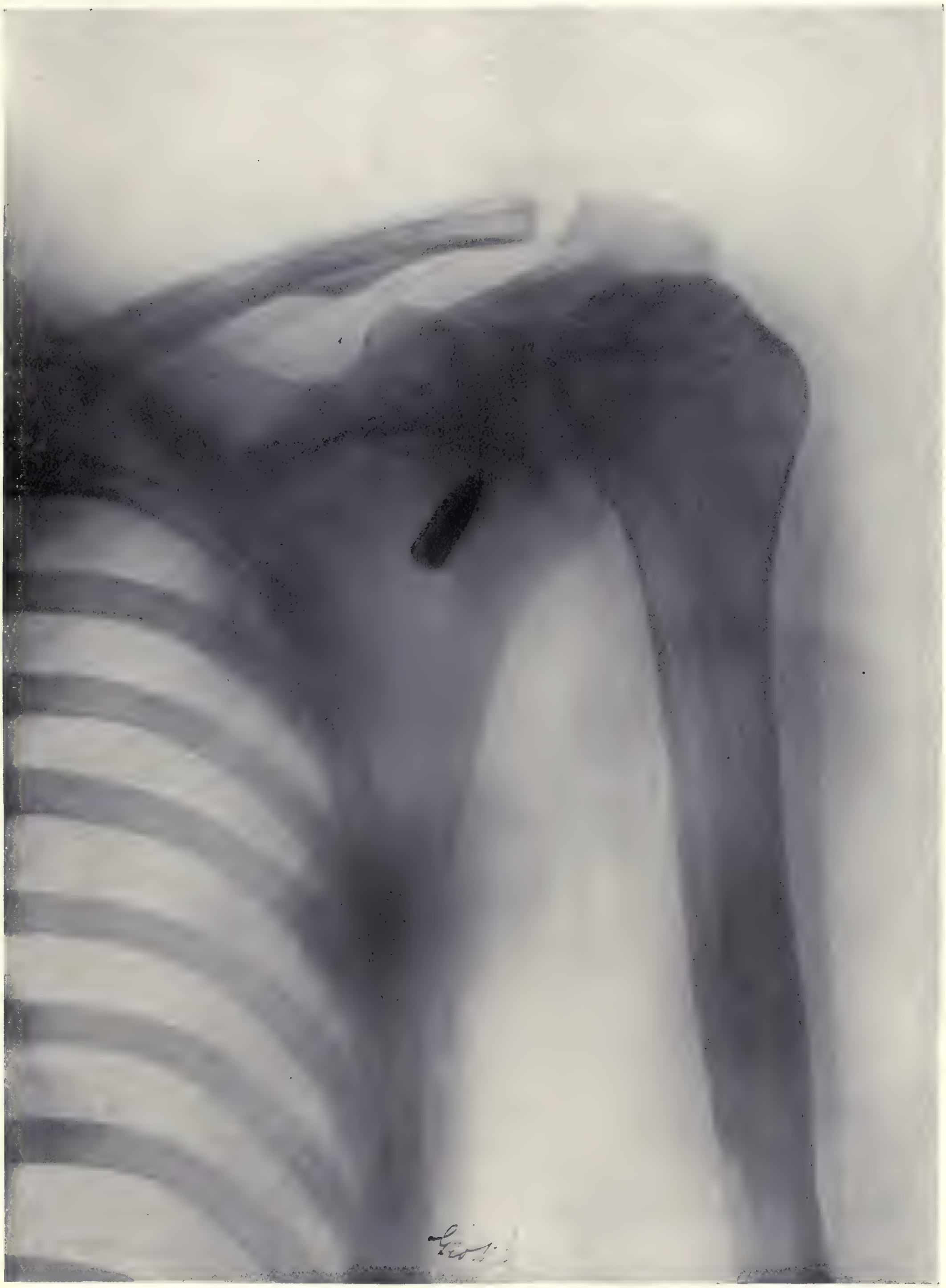

Fig. 1.—Radiograph to illustrate the Velocity of the Rifle Bullet as a determining factor in the extent of an injury.

PLATE 25.

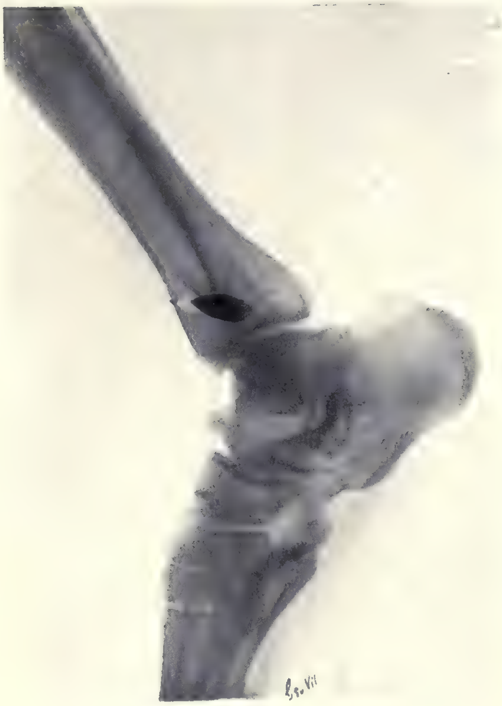

Fig. 2

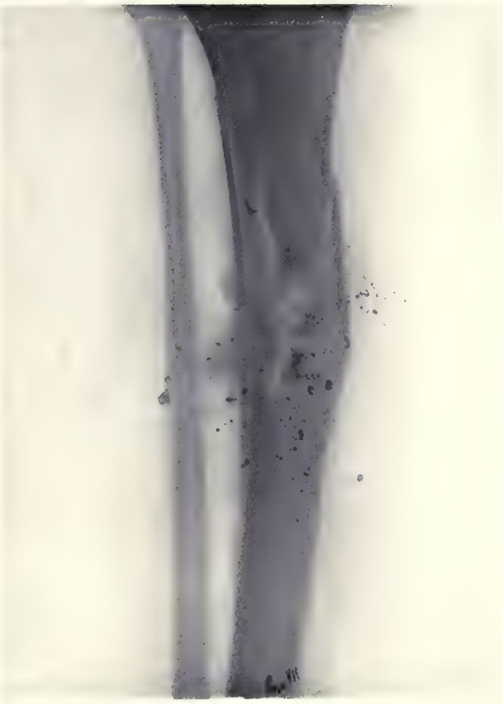

Fig. 3.

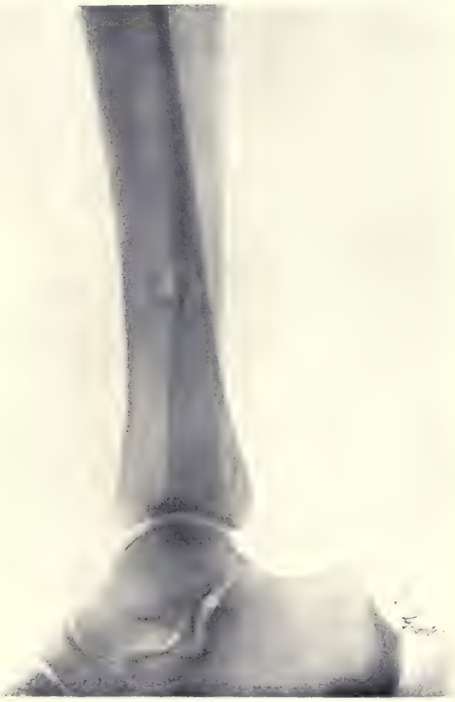

Fig. 4.

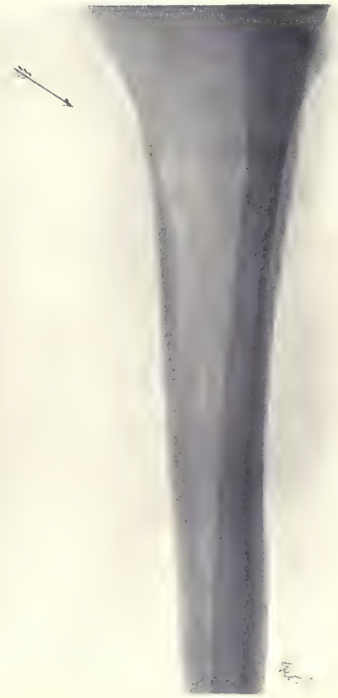

Fig. 5.

A few Radiograms to illustrate the Velocity of the Rifle Bullet as the determining factor in the extent of an injury.

PLATE 26.

so very little interference with the parts that clinically no damage to the bone was suspected.

In the third we find extensive injury and fragments of the bullet casing. The bullet perforated the tibia, comminuting the bone. At first sight one may be tempted to think of an explosive bullet; this is not so. The patient's leg on admission was œdematous, and presented two small wounds, one on either side. The temperature was 100·6 F., and on the third day 99·0 F. The case was under the care of Lieutenants T. T. Higgins and A. F. Rook.

In the fourth case the bullet travelled so fast that it bored the long bone clean through, causing no radiating fracture visible on the radiogram; nothing but a clean round hole. This patient was under the care of Lieut. Shutte, who tells me that except for some troublesome oozing for a few days the patient was little the worse for his wound.

The fifth case ranges in severity between the third and the former, and shows a vertical fracture of the shaft.

To my mind this series of cases illustrates the point that the damage done by rifle bullets is dependent on the velocity of the missile rather than on the texture of the bone.

In the first a "dead" missile. The second going at a greater velocity, yet not sufficient to perforate the bone completely, but settling comfortably at the end of its "burrow."

The third, on the other hand, in its mad career of destruction, pushed everything in front of it, first one compact side of the bone through the matrix, and then out through the other side, thus causing extensive damage; yet its speed was not such as to prevent some "wobbling," as evidenced by the shape of the fracture.

In the fourth and fifth cases, especially the former, the highest velocity causes the bullet to perform the work of a clean, sharp punch.

To the above-mentioned gentlemen I tender my thanks for permission to publish these few cases, nor would I forget my assistant for his careful attention to plates and prints.

REPORTS OF SOCIETIES.

At a recent meeting of the American Electro-Therapeutic Association, the following elections were made:—1915-1916.

President—
Dr. JEFFERSON D. GIBSON,
Denver, Colo.

Vice-Presidents—
Dr. J. WILLARD TRAVELL,
27, East 11th St., N. Y. City.

„ FRANK B. GRANGER,
591, Beacon St., Boston, Mass.

„ WILLIAM L. CLARK,
1809, Chestnut St., Phila, Pa.

„ SIDNEY A. TWINCH,
24, Fulton St., Newark, N. J.

„ WILLIAM MARTIN,
Atlantic City, N. J.

Treasurer—
Dr. EMIL HEUEL,
151, West St., N. Y. City.

Secretary—
Dr. BYRON SPRAGUE PRICE,
65, Central Park West, N. Y. City.

Registrar—
Dr. FREDERICK M. LAW,
576, Fifth Ave., N. Y. City.

Board of Trustees—One year:
Dr. CHARLES REA DICKSON,
192, Bloor St. West, Toronto, Canada.

„ EDWARD C. TITUS,
127, West 11th Street, N. Y. City.

Two years:—
Dr. GEORGE E. PFAHLER,
1321, Spruce St., Phila, Pa.

„ FREDERICK De KRAFT,
148, West 70th St., N. Y. City.

Three years:—
Dr. FRED HARRIS MORSE,
462, Boylston St., Boston, Mass.

„ JOHN W. TORBETT,
Marlin, Texas.

NATIONAL AND STATE MEDICAL SOCIETIES OF AMERICA.

Taken from "The Medical Record," September, 1915.

NATIONAL.

AMERICAN MEDICAL ASSOCIATION.

Annual Meeting at Detroit, Mich., June 12-16, 1916. Alex. R. Craig, M.D., Sec., 535, N. Dearborn St., Chicago, Ill. William L. Rodman, M.D., Prest., Philadelphia, Pa.

CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS.

Next Meeting at Washington, D. C., May, 1916. W. R. Steiner, M.D., Sec., 4, Trinity St., Hartford, Conn. Wm. C. Gorgas, M.D., Prest., Washington, D. C.

ASSOCIATION OF AMERICAN PHYSICIANS.

Annual Meeting at Washington, D. C., May 7-8, 1916. Geo. M. Kober, M.D., Sec., Washington, D.C. Henry Sewall, M.D., Prest., Denver, Col.

AMERICAN SURGICAL ASSOCIATION.

Annual Meeting at Washington, D. C., May 9-11, 1916. John H. Gibbon, M.D., Sec., 1608, Spruce St., Philadelphia, Pa. Robert G. LeConte, M.D., Prest., 1530, Locust St., Philadelphia, Pa.

CLINICAL CONGRESS OF SURGEONS OF NORTH AMERICA.

Annual Meeting at Boston, Mass., Oct. 25-30, 1915. Franklin H. Martin, M.D., Sec., Chicago, Ill. John B. Murphy, M.D., Prest., Chicago, Ill.

AMERICAN ACADEMY OF MEDICINE.

Annual Meeting at Detroit, Mich. (date not yet decided), 1916. Helen C. Putnam, M.D., Sec., Providence, R. I. Woods Hutchison, M.D., Prest., New York City.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY.

Annual Meeting at Chicago, Ill., Oct. 5-7, 1915. Lee M. Francis, M.D., Sec., 575, Delaware Ave., Buffalo, N. Y. Jos. C. Beck, M.D., Prest., Chicago, Ill.

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS.

Annual Meeting at Washington, D. C., May, 1916. R. F. O'Neil, M.D., Sec., 379, Beacon St., Boston, Mass. Chas. H. Chetwood, M.D., Prest., New York.

AMERICAN ASSOCIATION OF IMMUNOLOGISTS.

Annual Meeting at Washington, D. C., May, 1916. Martin J. Synnott, M.D., Sec., Montclair, N. J. James W. Jobling, M.D., Prest., Nashville, Tenn.

AMERICAN ASSOCIATION OF OBSTETRICIANS AND GYNECOLOGISTS.

Annual Meeting at Pittsburg, Pa., Sept. 21, 22, 23, 1915. E. Gustav Zinke, M.D., Sec., Cincinnati, Ohio. Charles L. Bonifield, M.D., Prest., Cincinnati, Ohio.

AMERICAN ASSOCIATION OF RAILWAY SURGEONS.

Annual Meeting at Chicago, Ill., Oct. 13-15, 1915. Louis J. Mitchell, M.D., Sec., 29, East Madison St., Chicago, Ill. Geo. F. Beasley, M.D., Prest., Lafayette, Ind.

AMERICAN ASSOCIATION OF MEDICAL EXAMINERS.

Annual Meeting at (not yet decided), 1915, F. K. Collins, M.D., Sec., 2501, North 32nd St., Philadelphia, Pa. A. T. Gaillard, M.D., Prest., Philadelphia, Pa.

AMERICAN CLIMATOLOGICAL AND CLINICAL ASSOCIATION.

Annual Meeting at Washington, D. C., May 9-10, 1916. Guy Hinsdale, M.D., Sec., Hot Springs, Va. Jas. Alexander Miller, M.D., Prest., New York.

AMERICAN DERMATOLOGICAL ASSOCIATION.

Annual Meeting at Washington, D. C. (date not yet decided), 1916. Oliver S. Ormsby, M.D., Sec., 25, E. Washington St., Chicago, Ill. Charles J. White, M.D., Prest., 259, Marlborough St., Boston, Mass.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.

Annual Meeting at Atlantic City, N J., Sept. 14-16, 1915. J. W. Travell, M.D., Sec., 27, E. 11th St., New York, N. Y. John W. Torbett, M.D., Prest,, Marlin, Texas.

AMERICAN GASTRO-ENTEROLOGICAL ASSOCIATION.

Annual Meeting at Baltimore, Md., May 10, 1916. F. W. White, M.D., Sec., 322, Marlborough St., Boston, Mass. Charles D. Stockton, M.D., Prest., Buffalo, N. Y.

AMERICAN GYNECOLOGICAL ASSOCIATION.

Annual Meeting at
LeRoy Broun, M.D., Sec., 148, W. 77th St., New York City. Thos. J. Watkins, M.D., Prest., Chicago, Ill.

AMERICAN LARYNGOLOGICAL ASSOCIATION.

Annual Meeting at (not yet decided), 1916. Harmon Smith, M.D., Sec., 44, W. 49th St., New York, N. Y. G. Hudson Makuen, M.D., Prest., Philadelphia, Pa.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL, AND OTOLOGICAL SOCIETY.

Annual Meeting at (not yet decided), 1916. Thos. J. Harris, M.D., Sec., 104, E. 40th St., New York, N. Y. S. MacCuen Smith, M.D., Prest., Philadelphia, Pa.

AMERICAN MEDICO-PSYCHOLOGICAL ASSOCIATION.

Annual Meeting at New Orleans, La., March, 1916. Henry C. Eyman, M.D., Sec., Massillon, Ohio. Edward N. Brush, M.D., Prest., Towson, Md.

AMERICAN MEDICAL EDITOR'S ASSOCIATION.

Annual Meeting at New York, October, 1915. J. MacDonald, Jr., M.D., Sec., 92, William St., New York, N. Y. H. Edwin Lewis, M.D., Prest., New York, N. Y.

AMERICAN NEUROLOGICAL ASSOCIATION.

Annual Meeting at (not yet decided), 1916. Alfred R. Allen, M.D., Sec., 2013, Spruce St., Philadelphia, Pa. Lewellyn F. Barker, M.D., Prest., Baltimore, Md.

AMERICAN OPHTHALMOLOGICAL SOCIETY.

Annual Meeting at Washington, D. C., May 9-10, 1916. Wm. M. Sweet, M.D., Sec., 1205, Spruce St., Philadelphia, Pa. G. E. de Schweinitz, M.D., Prest., Philadelphia, Pa.

AMERICAN ORTHOPEDIC ASSOCIATION.

Annual Meeting at Washington, D. C., May, 1916. H. Winnett Orr, M.D., Sec., Lincoln, Neb. Chas. F. Painter, M.D., Prest, Boston, Mass.

AMERICAN OTOLOGICAL SOCIETY.

Annual Meeting at Washington, D. C., May 9-10, 1916. John B. Rae, M.D., Sec., 247, West 70th St., New York, N. Y. Chas. W. Richardson, M.D., Prest., Washington, D. C.

AMERICAN PEDIATRIC SOCIETY.

Annual Meeting at Washington, D. C., May 8-10, 1916. Samuel S. Adams, M.D., Sec., Washington, D. C. Rowland Godfrey Freeman, M.D., Prest., New York, N. Y.

AMERICAN PROCTOLOGIC SOCIETY.

Annual Meeting at Detroit, Mich., June, 1916. Alfred J. Zobel, M.D., Sec., San Francisco, Cal. T. Chittenden Hill, M.D., Prest., Boston, Mass.

AMERICAN PUBLIC HEALTH ASSOCIATION.

Annual Meeting at Rochester, N. Y., Sept. 7-10, 1915. Selskar M. Gunn, Sec., 755, Boylston St., Boston, Mass. Wm. T. Sedgwick, Prest., Boston, Mass.

AMERICAN ROENTGEN RAY SOCIETY.

Annual Meeting at Atlantic City, N. J., Sept. 22-25, 1915. Willis F. Manges, M.D., Sec., Philadelphia, Pa. A. L. Gray, M.D., Prest., Richmond, Va.

AMERICAN THERAPEUTIC SOCIETY.

Annual Meeting at Detroit, Mich. (date not yet decided), 1916. Lewis H. Taylor, M.D., Sec., The Cecil, Washington, D.C. Robt. T. Morris, M.D., Prest., 616, Madison Ave., New York, N. Y.

AMERICAN UROLOGICAL ASSOCIATION.

Annual Meeting at St. Louis, Mo., April, 1916. Henry L. Sanford, M.D., Sec., Osborn Bldg., Cleveland, Ohio. E. L. Keyes, Jr., M.D., Prest., New York, N. Y.

ASSOCIATION OF AMERICAN MEDICAL COLLEGES.

Annual Meeting at Chicago, Ill., February, 1916. Fred. C. Zapffe, M.D., Sec., 3431, Lexington St., Chicago, Ill. Chas. R. Bardeen, M.D., Prest., Madison, Wis.

ASSOCIATION OF MILITARY SURGEONS OF THE UNITED STATES.

Annual Meeting at Washington, D. C., Sept. 13-15, 1915. Brig.-Gen. S. C. Stanton, Sec., 535, N. Dearborn St., Chicago, Ill. Jefferson R. Kean, U.S.A., Prest., Fort Leavenworth, Kan.

FEDERATION OF STATE MEDICAL BOARDS OF THE UNITED STATES.

Annual Meeting at Chicago, Ill., Feb. 7-8, 1916. Otto V. Huffman, M.D., Sec., Albany, N. Y. Charles H. Cook, M.D., Prest., Natick, Mass.

MEDICAL SOCIETY OF THE MISSOURI VALLEY.

Annual Meeting at Des Moines, Iowa, Sept. 23-24, 1915. Chas. Wood Fassett, M.D., Sec., St. Joseph, Mo. Granville N. Ryan, M.D., Prest., Des Moines, Iowa.

MEDICAL ASSOCIATION OF THE SOUTH-WEST.

Annual Meeting at Oklahoma City, Okla., Oct. 12-13, 1915. Fred H. Clark, M.D., Sec., El Reno, Okla. J. P. Griffith, M.D., Prest., Kansas City, Mo.

MISSISSIPPI VALLEY MEDICAL ASSOCIATION.

Annual Meeting at Lexington, Ky., October, 1915. Henry Enos Tuley, M.D., Sec., 705, South Third St., Louisville, Ky. Hugh Cabot, M.D., Prest., Boston, Mass.

SOUTHERN SURGICAL AND GYNECOLOGICAL ASSOCIATION.

Annual Meeting at Cincinnati, Ohio, Dec. 14-16, 1915. W. D. Haggard, M.D., Sec., 148, 8th Ave., N., Nashville, Tenn. Bacon Saunders, M.D., Prest., Ft. Worth, Texas.

SOUTHERN MEDICAL ASSOCIATION.

Annual Meeting at Dallas, Texas, Nov. 8-11, 1915. Seale Harris, M.D., Sec., Birmingham, Ala. Oscar Dowling, M.D., Prest., Shreveport, La.

TRI-STATE MEDICAL ASSOCIATION OF THE CAROLINAS AND VIRGINIA.

Annual Meeting at Richmond, Va., Feb. 16-17, 1916. Rolfe E. Hughes, M.D., Sec., Laurens, S. C. Jas. H. McIntosh, M.D., Prest., Columbia, S. C.

WESTERN SURGICAL AND GYNECOLOGICAL ASSOCIATION.

Annual Meeting at Des Moines, Iowa, Dec. 17-18, 1915. Arthur T. Mann, M.D., Sec., Donaldson Bldg., Minneapolis, Minn. Jos. R. Eastman, M.D., Prest., Indianapolis, Ind.

CANADIAN MEDICAL ASSOCIATION.

Annual Meeting at
W. W. Francis, M.D., Sec., 836, University St., Montreal, P. Q. Murray MacLaren, M.D., Prest., St. John, N. B.

STATE.

MEDICAL ASSOCIATION OF THE STATE OF ALABAMA.

Annual Meeting at Mobile, Ala., April, 1916. H. G. Perry, M.D., Sec., Montgomery, Ala. J. N. Baker, M.D., Prest., Montgomery, Ala.

ARIZONA MEDICAL ASSOCIATION.

Annual Meeting at Phoenix, Ariz. (date not yet decided), 1916. C. E. Yount, M.D., Sec., Prescott, Ariz. Roy E. Thomas, M.D., Prest., Phoenix, Ariz.

ARKANSAS MEDICAL SOCIETY,

Annual Meeting at Texarkana, Ark., May, 1916. C, P. Meriwether, M.D , Sec., 309, S. Trust Bldg., Little Rock, Ark. J. C. Wallis, M.D., Prest, Arkadelphia, Ark.

CONNECTICUT STATE MEDICAL SOCIETY.

Annual Meeting at Bridgeport, Conn., May 17-18, 1916. M. M. Scarbrough, M.D., Sec., New Haven, Conn. Max Mailhouse, M.D., Prest., New Haven, Conn.

MEDICAL SOCIETY OF THE STATE OF CALIFORNIA.

Annual Meeting at (not yet decided), 1916. Philip M. Jones, M.D., Sec., 930, Butler Bldg., San Francisco, Cal. Harry M. Sherman, M.D., Prest., San Francisco, Cal.

COLORADO STATE MEDICAL SOCIETY.

Annual Meeting at Denver, Colo., Oct. 5, 1915. Crum Epler, M.D., Sec., Pueblo, Colo. Geo. B. Packard, M.D., Prest., Denver, Colo.

DELAWARE STATE MEDICAL SOCIETY.

Annual Meeting at Wilmington, Del., Oct. 14-15, 1915. G. W.K. Forrest, M.D., Sec., Wilmington, Del. Harry W. Briggs, M.D., Prest., Wilmington, Del.

FLORIDA MEDICAL ASSOCIATION.

Annual Meeting at Arcadia, Fla., May 12, 1916. Graham E. Henson., M.D., Sec., Jacksonville, Fla. R. H. McGinnis, M.D., Prest., Jacksonville, Fla.

MEDICAL ASSOCIATION OF GEORGIA.

Annual Meeting at
Wm. C. Lyle, M.D.· Sec., Augusta, Ga. W. B. Hardman, M.D., Prest., Commerce, Ga.

MEDICAL SOCIETY OF HAWAII.

Annual Meeting at Honolulu, H. I., Nov. 1915. F. E. Trotter, M.D., Sec., Honolulu, H. I. F. P. Reynolds, M.D., Prest., Honolulu, H. I.

ILLINOIS STATE MEDICAL SOCIETY.

Annual Meeting at Champaign, Ill., May 16-18, 1916. W.H.Gilmore, M.D., Sec., Mount Vernon, Ill. C. W. Lillie, M.D., Prest., East St. Louis, Ill.

IDAHO STATE MEDICAL SOCIETY.

Annual Meeting at Lewiston, Idaho, Oct. 1915. Ed. E. Maxey, M.D., Sec., Boise, Idaho. John N. Alley, M.D., Prest., Lapwai, Idaho.

INDIANA STATE MEDICAL ASSOCIATION.

Annual Meeting at Indianapolis, Ind., Sept. 23-24, 1915. Chas. N. Combs, M.D., Sec., Terre Haute, Ind. Frank B. Wynn, M.D., Prest., Indianapolis, Ind.

IOWA STATE MEDICAL SOCIETY.

Annual Meeting at Davenport, Ia., May 10, 11, 12, 1916. J. W. Osborn, M.D., Sec., Des Moines, Iowa. Wm. B. Small, M.D., Prest., Waterloo, Iowa.

KANSAS MEDICAL SOCIETY.

Annual Meeting at Topeka, Kan., May 6-7, 1916. Chas. S. Huffman, M.D., Sec., Columbus, Kan. O. D. Walker, M.D., Prest., Salina, Kan.

KENTUCKY STATE MEDICAL ASSOCIATION.

Annual Meeting at Louisville, Ky., October, 1915. Arthur T. McCormack, M.D., Sec., Bowling Green, Ky. John J. Moren, M.D., Prest., Louisville, Ky.

LOUISIANA STATE MEDICAL SOCIETY.

Annual Meeting at New Orleans, La., April 18-20, 1916. L. R. DeBuys, M.D., Sec., Maison Blanche Bldg., New Orleans, La. J. C. Willis, M.D., Prest., Shreveport, La.

MICHIGAN STATE MEDICAL SOCIETY.

Annual Meeting at Grand Rapids, Mich., Sept., 1915. F. C. Warnshuis, M.D., Sec., Grand Rapids, Mich. Reuben Peterson, M.D., Prest., Ann Arbor, Mich.

MINNESOTA STATE MEDICAL ASSOCIATION.

Annual Meeting at Rochester, Minn., Sept. 29-Oct. 1, 1916. Thos. McDavitt, M.D., Sec., 814, Lowry Bldg., St. Paul, Minn. John T. Rogers, M.D., Prest., St. Paul, Minn.

MISSISSIPPI STATE MEDICAL ASSOCIATION.

Annual Meeting at Greenville, Miss., May 9, 1916. E. F. Howard, M.D., Sec., 1st Nat'l Bank Bldg., Vicksburg, Miss. I. W. Cooper, M.D., Prest., Newton, Miss.

MISSOURI STATE MEDICAL ASSOCIATION.

Annual Meeting at St. Joseph, Mo., May 8-10, 1916. E. J. Goodwin, M.D., Sec., 3525, Pine St., St. Louis, Mo. C. R. Woodson, M.D., Prest., St. Joseph, Mo.

MONTANA STATE MEDICAL ASSOCIATION.

Annual Meeting at
E. G. Balsam, M.D., Sec., Billings, Mont. James H. Irwin, M.D., Prest., Great Falls, Mont.

MAINE MEDICAL ASSOCIATION.

Annual Meeting at Portland, Me., June, 1916. John B. Thompson, M.D., Sec., Bangor, Me. E. E. Holt, M.D., Prest., Portland, Me.

MEDICAL AND CHIRURGICAL FACULTY OF MARYLAND.

Annual Meeting at Baltimore, Md. (date not yet decided), 1916. J. I. France, M.D., Sec., 1211, Cathedral St., Baltimore, Md. J. W. Williams, M.D., Prest., Baltimore, Md.

MASSACHUSETTS MEDICAL SOCIETY.

Annual Meeting at Boston, Mass., June 7-8, 1916. Walter L. Burrage, M.D., Sec., 282, Newbury St., Boston, Mass. Chas. F. Withington, M.D., Prest., Boston, Mass.

NEW HAMPSHIRE MEDICAL SOCIETY.

Annual Meeting at Concord, N. H., May, 1916. D. E. Sullivan, M.D., Sec., 7, No. State St., Concord, N. H. Edgar O. Crossman, M.D., Prest., Lisbon, N. H.

MEDICAL SOCIETY OF THE STATE OF NEW YORK.

Annual Meeting at Saratoga Springs, N. Y., May 16, 1916. Wisner R. Townsend, M.D, Sec., 17, West 43rd St., New York, N. Y. W. Stanton Gleason, M.D., Prest., Newburgh, N. R.

MEDICAL SOCIETY OF NEW JERSEY.

Annual Meeting at Spring Lake, N. J., June 20-22, 1916. Thomas N. Gray, M.D., Sec., East Orange, N. J. Wm. J. Chandler, M.D., Prest., South Orange, N. J.

NEBRASKA STATE MEDICAL ASSOCIATION.

Annual Meeting at Omaha, Neb., May 23-25, 1916. Joseph M. Aikin, M.D., Sec., Omaha, Neb. E. W. Rowe, M.D., Prest., Lincoln, Neb.

NEW BRUNSWICK MEDICAL SOCIETY

Annual Meeting at St. John, N.B., July 18, 1916. D. C. Malcolm, M.D., Sec., St. John, N. B. W. W. White, M.D., Prest., St. John, N. B.

MEDICAL SOCIETY OF THE STATE OF NORTH CAROLINA.

Annual Meeting at Durham, N. C., April 19, 1916. Benjamin K. Hays, M.D., Sec., Oxford, N. C. M. H. Fletcher, M.D., Prest., Asheville, N. C.

NEW MEXICO MEDICAL SOCIETY.

Annual Meeting at Las Vegas, N. M., Sept. 6-8, 1915. R. E. McBride, M.D., Sec., Las Cruces, N. M. Wm. T. Joyner, M.D., Prest., Roswell, N. M.

NORTH DAKOTA STATE MEDICAL ASSOCIATION.

Annual Meeting at Devils Lake, N. D., May 10-11, 1916. H. J. Rowe, M.D., Sec., Casselton, N. D. Victor Hugo Stickney, M.D., Prest., Dickinson, N. D.

OHIO STATE MEDICAL ASSOCIATION.

Annual Meeting at Cleveland, Ohio, May, 1916. C. D. Selby, M.D., Sec., Toledo, Ohio. W. E Lower, M.D., Prest., Cleveland, Ohio.

OKLAHOMA STATE MEDICAL ASSOCIATION.

Annual Meeting at Oklahoma City, Okla. May, 1916. C. A. Thompson, M.D., Sec., Muskogee, Okla. J. Hutching White, M.D., Prest., Muskogee, Okla.

OREGON STATE MEDICAL ASSOCIATION.

Annual Meeting at Portland, Ore., Sept. 10-11, 1915. M. B. Marcellus, M.D., Sec. 901, Selling Bldg, Portland, Ore. A. E. Rockey, M.D. Prest., Portland, Ore.

MEDICAL SOCIETY OF THE STATE OF PENNSYLVANIA.

Annual Meeting at Philadelphia, Sept. 20-23, 1915. Cyrus Lee Stevens, M.D., Sec., Athens, Pa. Edward B. Heckel, M.D., Prest., Pittsburg, Pa.

RHODE ISLAND MEDICAL SOCIETY.

Annual Meeting at Providence, R. I., June 1, 1916. J. Perkins, M.D., Sec., 125, Waterman St., Providence, R. I. Frank L. Day, M.D.. Prest., Providence, R. I.

SOUTH DAKOTA STATE MEDICAL ASSOCIATION.

Annual Meeting at Aberdeen, S. D., May, 1916, R. D. Alway, M.D., Sec., Aberdeen, S. D. J. B. Vaughn, M.D., Prest., Castlewood, S. D.

SOUTH CAROLINA MEDICAL ASSOCIATION.

Annual Meeting at Charleston, S. C., April 19, 1916. Edgar A. Hines, M.D., Sec., Seneca, S. C. G. A. Neuffer, M.D., Prest., Abbeville, S. C.

TENNESSEE STATE MEDICAL ASSOCIATION.

Annual Meeting at Knoxville, Tenn., April. 1916. Olin West, M.D., Sec., Independent Life Bldg.. Nashville, Tenn. E. C. Ellett, M.D., Prest., Memphis, Tenn.

STATE MEDICAL ASSOCIATION OF TEXAS.

Annual Meeting at Galveston, Tex., May, 1916. H. Taylor, M.D., Sec., Fort Worth, Tex. G. H. Moody, M.D., Prest., San Antonio, Tex.

UTAH STATE MEDICAL ASSOCIATION.

Annual Meeting at Salt Lake City, Utah, Sept. 28-29, 1915. Wm. Brown Ewing, M,D., Sec., Salt Lake City, Utah. R. S. Joyce, M.D., Prest., Ogden, Utah.

VERMONT STATE MEDICAL SOCIETY.

Annual Meeting at Burlington, Vt., Oct. 14 and 15, 1915. J. M. Hamilton, M.D., Sec., Rutland, Vt. Wm. W. Townsend, M.D., Prest., Rutland, Vt.

VIRGINIA STATE MEDICAL SOCIETY.

Annual Meeting at Richmond, Va., Oct. 26-29, 1915. Paulus A. Irving, M.D., Sec., Farmville, Va. Samuel Lile, M.D., Prest., Lynchburg, Va.

WASHINGTON STATE MEDICAL ASSOCIATION.

Annual Meeting at Seattle, Wash. (date not yet decided,) 1916. C. H. Thompson, M.D., Sec., Seattle, Wash. J. M. Semple, M.D., Prest., Spokane, Wash.

STATE MEDICAL SOCIETY OF WISCONSIN.

Annual Meeting at Milwaukee, Wis., Oct. 6-8, 1915. Rock Sleyster, M.D., Sec., Waupun, Wis. Theodore J. Redelings, M.D., Prest., Marinette, Wis.

WEST VIRGINIA STATE MEDICAL ASSOCIATION.

Annual Meeting at Wheeling, W. Va., May, 1916. J. Howard Anderson, M.D., Sec., Marytown, W. Va. A. P. Butt, M.D., Prest., Davis, W. Va.

WYOMING STATE MEDICAL SOCIETY.

Annual Meeting at
W. H. Roberts, M.D., Sec., Sheridan, Wyo. Amos W. Barber, M.D., Prest., Cheyenne, Wyo.

REVIEWS.

An Introduction to Surgery. By RUTHERFORD MORISON, M.A., M.B., F.R.C.S. Edin. and Eng.; Professor of Surgery, University of Durham. With 146 illustrations in the text and three coloured plates. John Wright and Sons, Limited. London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.

The author in his preface states that his chief object in writing this book has been to emphasise the importance of general principles of surgery in the hope that the reader will be induced to apply these principles in his every-day work, and be led to think out for himself matters which may be found in large text-books.

A survey of the subject matter of the book convinces one that the author has succeeded in placing before the student an excellent introduction to the subject of general surgery, and this little book will be most useful to students and practitioners.

The book is excellently produced, the illustrations being clear and full of detail likely to be useful. It contains a number of interesting radiograms; the majority of these are good, though one would have liked to see radiograms selected which would have better illustrated fine detail in bone; these have obviously been printed from under-exposed plates. Fig. 47 is one example of this kind. Fig. 66 also hardly succeeds in illustrating the fine detail in bone. Fig. 108, renal calculi, might have been better illustrated by a good plate.

The book concludes with a section headed "X rays," in which the author says:—

"The advantages of X rays as an aid to diagnosis and treatment are even yet not sufficiently appreciated." He then proceeds to demonstrate the class of case where radiography is likely to establish a diagnosis and possibly prevent a serious error. Several interesting radiograms are utilized to show how usefully X rays may be employed. The book is unreservedly recommended to all who desire to read a clearly expounded treatise on the general principles of surgery.

The Medical Annual. A Year-Book of Treatment and Practitioners' Index. 1915. John Wright and Sons, Ltd., Bristol.

This important annual publication well maintains the high standard of former years; the contributors and publishers are to be commended for the manner in which they have discharged their duties under circumstances which have been most trying to all, and particularly antagonistic to the production of literary matter. The book forms a complete *résumé* of the medical work of the year, and hardly any detail has been overlooked. The illustrations are of a high standard, several of the colour plates being works of art; the half-tone reproductions of radiographic work leave nothing to be desired.

The recent developments in the departments of radiography, radio-therapeutics, radium, and electrotherapy are dealt with in an article by C. Thurstan Holland. Attention is directed to the recent developments in apparatus; a description of the Coolidge tube draws attention to one of the most important advances in tube construction since the introduction of X rays. The future experiences of the use of this tube will no doubt be one of the features of the succeeding volumes.

Morton's apparatus for the suppression of inverse current is also dealt with at some length.

Corbett's new radiometer deservedly comes in for favourable description.

The remarks on X-ray diagnosis open with the diagnosis of gall stones. It would appear that with improvements in technique the possibility of diagnosing gall stones is becoming more certain.

Pfahler claims that he can show gall stones in at least 30 per cent. of his cases. Even if a less liberal estimate is accepted this marks a distinct advance in the value of X rays in this branch of radiography.

The standardization of the opaque meal is advocated for obvious reasons.

The work of Howard Pirie on the radiography of the pyloric antrum and first part of duodenum is also noted as an advance in technique.

The portion of the article devoted to X-ray and radium therapeutics is full and notes all the really important work done during the year.

One is struck by the frequency of the references to X rays and radium in the articles throughout the book, evidence that the value of these agents is not being overlooked by our colleagues working in other specialised branches of medical work.

Consisting, as it does, of a *résumé* of the year's work in all branches of medicine and surgery, the book cannot fail to be of the greatest possible value to all radiologists. The special articles on the stomach and other regions of the alimentary canal are of interest, particularly when the clinical side of the subject is dealt with. Of these there are a number illustrated by good plates. The book is essentially one which should be carefully read by all practising radiologists for the double reason that not only does it fully deal with subject matter indicating the advances in radiology, but also with the many other subjects of general interest which should prove of great value to radiologists from the point of view of diagnosis and of general interest in their work.

The Medical Annua Synoptical Index. For the ten years 1905 to 1914. Published by John Wright and Sons, Bristol. Pp. 375.

"The Medical Annual" is a well-known and valued synopsis of the papers that have appeared in the medical journals during each year. The present book is an index to the ten volumes of "The Medical Annual" that have appeared during the years 1905 to 1914 inclusive. In tha index will be found, arranged in alphabetical order, diseases, symptoms, drugs, methods of treatment, apparatus, etc., and against each is placed the number of the volume and page of the "Annual" that contains information on the subject indexed that has appeared in the medical journals published between 1905 and 1914. Reference to the original communications will be found in "The Medical Annual." A brief synopsis of new drugs and methods of treatment is given in the "Index," so that no further reference is necessary.

In addition there is a list of drugs, with doses in imperial and metric measure, in accordance with the British Pharmacopœia of 1914, and the alterations that have been made are indicated.

The "Index" contains an enormous number of references, and is full of most useful information. Those who are interested in radiology and electrotherapy will find references to a large number of papers on X rays in diagnosis and treatment, on radium therapy, on ionic medication and high-frequency. There are two references to papers on diathermy, although there is no reference to papers that have appeared on this subject in 1914. There is no reference to the use of condenser discharges for testing and treatment.

The "Index" is clear and well printed, and as a guide to medical literature is almost indispensable to the general practitioner and the specialist.

NEW INSTRUMENTS.

A SIMPLE SCREENING METHOD OF LOCALIZATION WITH THE X-RAYS.

By Harold J. Stenning.

Description of Apparatus.—This method requires the use of a special localizing mat of very simple construction. A number of straight pieces of lead wire are embedded in a sheet of material transparent to the rays in such a manner that they are parallel to one another and at equal distances apart (viz. 1 inch). Lead figures are also provided so that when the mat is placed between a working X-ray tube and a fluorescent screen, the shadow of a divided scale is seen on the latter.

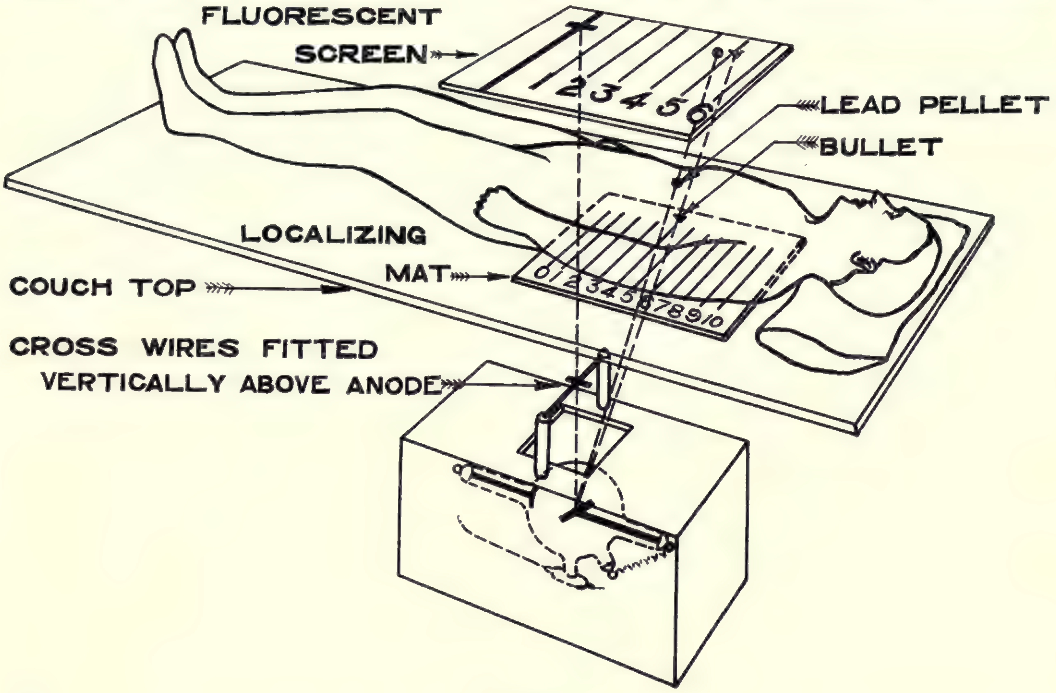

Fig. 1.

When working with a couch having a 3-ply wood top, which yields very little under the weight of the patient, the localizing mat is simply laid on the surface of the couch. When, however, it has to be used with a couch having a canvas top, the mat is suspended underneath on two wires stretched tightly between the end frames. In order to obtain the best results, it should be fitted as close as possible to the patient, without actually touching the canvas. It can then be slid well out of the way when not required.

By measuring the vertical distance from the anode to the surface of the mat, curves can be plotted, as explained later, by means of which the height of any body above the mat can be easily and accurately determined.

(The curve, Fig. 2, is for a couch in which this distance was 18 inches.)

In order to mark a point on the patient directly above the object to be located, cross wires are fitted to the tube box. These wires also allow the necessary movements to be given to the box without reference to the stereoscopic scales of the couch. This is an advantage when screen localization is being carried out, as the radiographer, whose eyes have become accustomed to the darkened room, does not have to turn on the light until he has completed his examination.

It should be noted that the greater the distance between the cross wires and the anode of the tube, the sharper will be the shadow cast by them on the fluorescent screen.

Method of Working.—

(*a*) The patient is placed on the couch with the bullet or other object as nearly as possible over the centre of the localizing mat.

(*b*) The tube box is moved about underneath the couch until the shadow of the cross wires coincides with the shadow of the bullet. A small pellet of lead is then placed on the patient in such a position that its shadow also falls on the same spot. Provided the cross wires have been accurately fitted, we now know that the pellet of lead is vertically above the bullet.

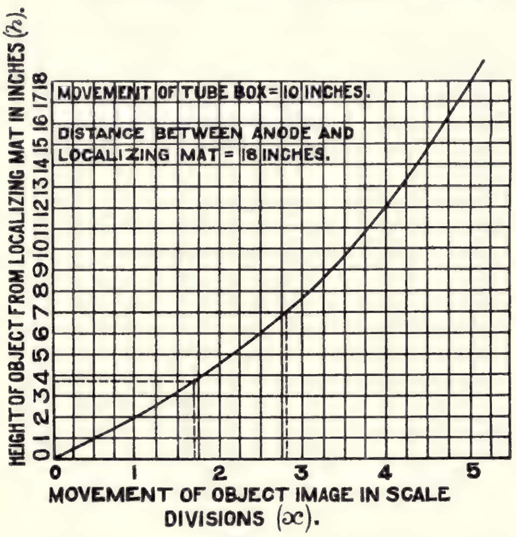

Fig. 2.

(*c*) The tube box is moved to such a position that the shadow of the longer cross wire coincides with the shadow of the zero line of the localizing mat. The anode (see Fig. 1) is then directly below this line. The positions occupied by the bullet and the lead pellet, as seen in relation to the shadow of the scale on the fluorescent screen, are noted.

(See Fig. 1, where the position of the bullet is 5·0 and that of the lead pellet 4·5.)

(*d*) The tube box is moved until the shadow of the longer cross wire coincides with the shadow of line No. 10 of the scale. The distance it has been moved is, of course, equal to the length of the scale. The position of the bullet and of the lead pellet on the fluorescent screen are again noted.

(Suppose the new position of the bullet to be 6·7 and that of the pellet to be 7·3.)

The two readings for the bullet are subtracted, the one from the other, and, by referring to the curve, Fig. 11, the height from the mat corresponding to this movement of the object image is found.

(6·7 − 5 = 1·7. The height from the mat corresponding to this difference is 3·75 ins.)

In a similar manner the height of the lead pellet from the mat is determined.

(7·3 − 4·5 = 2·8. The height corresponding to this difference is 7 ins.)

Knowing the distance of the bullet from the mat, and the distance between the lead pellet and the same datum, the depth of the bullet below the lead pellet is at once apparent.

(The depth of the bullet below the lead pellet = 7 − 3·75 = 3·25 ins.)

The advantages of this method may be summarised as follows:—

(1) The apparatus is simple and inexpensive.

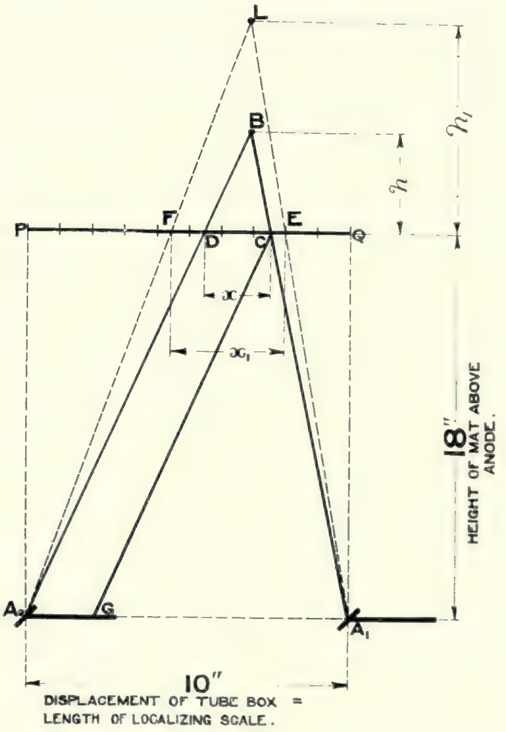
L
B
h
h_1
F
E
P
D
C
Q
x
x_1
18"
HEIGHT OF MAT ABOVE ANODE.
A_2
G
A_1
10"
DISPLACEMENT OF TUBE BOX = LENGTH OF LOCALIZING SCALE.

Fig. 3.

(2) It can be adapted to almost any design of couch.

(3) Stereoscopic scales are not necessary.

(4) The fluorescent screen need not be held

horizontally, and does not have to touch the patient.

Plotting the Curve.—Let A_1 and A_2 (see Fig. 3) represent the two positions of the anode moving at a distance, in this case of 18 inches, below the scale of the localizing mat, PQ.

The rays which strike the bullet B, intersect the scale at D and C, so that the movement of the bullet image across the scale, as seen on the fluorescent screen, corresponds with the distance X. The lead pellet L is placed vertically above the bullet, and the rays which pass through it cut the scale at E and F.

A general formula can easily be obtained, which gives us the height of any body (such as B or L) from the localizing mat by noting the movement of its shadow. Let h be the height of the bullet from the localizing mat.

Draw C G parallel to $B.A_2$.

Then the triangles B D C and C G A_1 are similar.

$$\therefore \quad \frac{h}{x} = \frac{18}{10-x}$$

$$\text{or} \quad h = \frac{18\ x}{10-x}$$

This formula can also be applied to find the height of the lead pellet or of any other object above the localizing mat, provided that the correct value for x is inserted.

$$h_1 = \frac{18\ x_1}{10-x_1}$$

By substituting a number of different values for x, the corresponding values for h are calculated, and from these the curve, Fig. 2, is plotted.

As already explained, the height of the bullet (h) and of the lead pellet (h_1) are both obtained from this curve. The difference (h_1—h) gives the vertical depth of the bullet below a known point on the patient's skin.

Plate Localization.—Sometimes a number of small pieces of shrapnel have to be located, which cannot be at all clearly distinguished by a screen examination. By placing the patient on a localizing mat, and by exposing two plates, the tube box being given a movement of 10 ins. between each exposure, it is possible to obtain the height of any distinguishable object from the mat.

The apparatus described in these notes is manufactured by Messrs. Harry W. Cox & Co., Ltd., 159, Great Portland Street, W., who will also supply the necessary curve for any particular couch.

ENQUIRY COLUMN.

B. C. D.,—I am trying to find out how to get the greatest flesh values and detail out of X-ray plates when reproduced. Can you find out for me or put me in touch with the proper persons who will tell me what kind of photographic paper they use, or anything about the technique employed to get the best results.

I notice the "Fortschritte Roentgenstrahlen" also has illustrations of this character.

[If the negative is a thin one, *i.e.*, under-exposed, a slow contact paper should be used (Gravura No. 2), or one of the many gas-light papers on the market, a long exposure is necessary and a weak developer should be used. When the negative is a strong one a short exposure on a bromide paper will bring out the detail, a weak developer is again indicated.]

ERRATUM.

In the issue of the ARCHIVES of July, 1915, Mr. Blake describes the method of localization used by him at Richmond; a misprint in a reference obscures the fact that this is a modification of the method devised by Professor Barrell. ["A new method of localization without plumb-lines or threads," ARCHIVES OF THE ROENTGEN RAY, May, 1900.] The use of the triangular marker, the bar connecting two plates to obviate the use of a very large plate, the use of a distance piece, and mounting the cylinders in wax, are additions by Mr. Blake.

CORRESPONDENCE.

St. John's Hospital,
Leicester Square,
Oct. 1*st*, 1915.

To the Editors of the ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY.

SIRS,—I wish to thank Dr. Mottram for his kindly criticism of my article entitled "The Inhibitive Effect of X rays upon Malignant Growths."

If Dr. Mottram will again carefully read my article he will find that I have fully stated my reasons for believing the disappearance of the malignant cells to be due to the inhibition of their power of reproduction caused by the exposure to X rays.

Dr. Mottram is, of course, aware that the disappearance of all cells is a natural phenomenon dependent upon the flux of time, and does not necessarily infer their destruction by the X rays.

Yours faithfully,

CHRISTOPHER KEMPSTER.

NOTICES.

ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY is published monthly.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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THE VALUE OF THE ELECTROCARDIOGRAPH IN THE DIAGNOSIS OF DISEASES OF THE HEART.

By George E. S. Ward, M.D., B.S. (London), M.R.C.P.
Clinical Assistant in the Electrocardiographic Department, Middlesex Hospital.

Electrocardiography depends entirely upon the well known fact that when a muscle, or portion of muscle, is stimulated to contract, an electrical current is generated in that muscle.

If a strip of muscle is taken, and a galvanometer is attached to each end of the muscle by means of non-polarisable electrodes, it will be found that each time a single induction shock is passed through the muscle, a deflection of the galvanometric needle will take place. Further, it will also be evident that the direction of such deflection depends upon the direction in which the induction shock passes through the muscle.

The electrocardiograph from which the illustrations of this article were obtained, is a special form of "string" galvanometer, which was first invented by the Dutch physiologist, Einthoven. This instrument is very suitable for obtaining records of the electrical changes resulting from the contractions of the heart; for very minute electrical currents cause measureable deflections of the "string" of the galvanometer. This "string" is in reality a finely drawn silvered quartz fibre, which is suspended between the two poles of an electro-magnet. The shadow of this fibre is projected by means of an arc lamp on to the horizontal slit of a camera, and is magnified by an appropriate optical system to a convenient size. The camera is so constructed that the shadow of the fibre is at right angles to the slit of the camera. Any current passing through this fibre produces a deflection of it in a lateral direction, so that a photographic plate falling vertically behind the slit of the camera records these deflections as waves in an upward or downward direction.

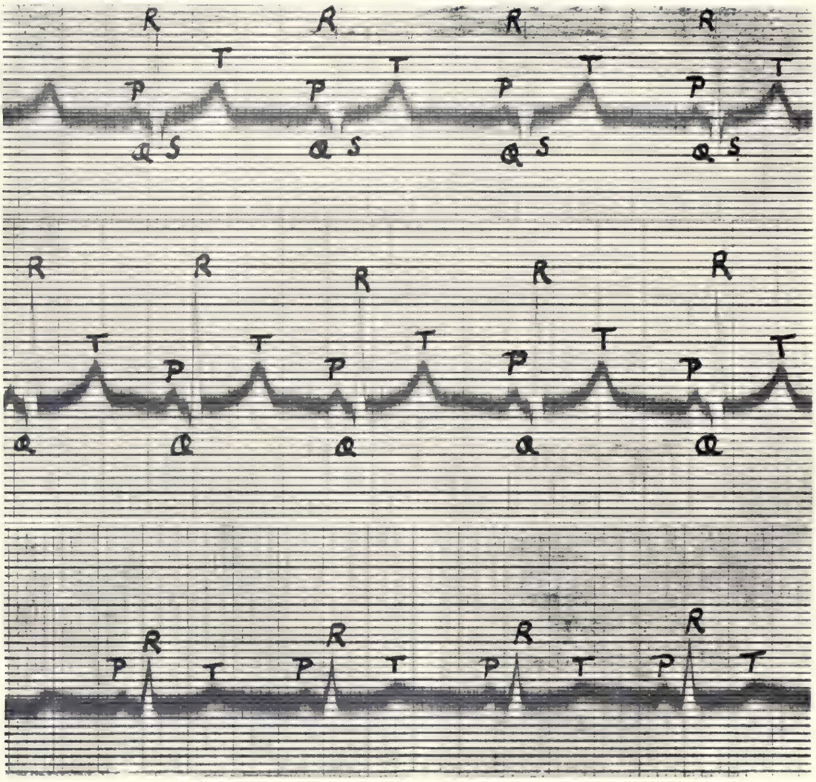


Fig. 1.—The three Leads of a normal electrocardiogram.*

This fibre can be loosened or tightened as required, so that it is possible to obtain a standard degree of lateral deflection for a definite electrical current. The usual standard is when 3 millivolts applied to the fibre cause 30

*In the illustrations shown in this article, the thin horizontal parallel lines merely indicate in millimetres the height or depth of the waves. The vertical lines are produced by a rotatory time-marker; the broader lines measuring intervals of one-fifth seconds, the fine lines one-twenty-fifth seconds. The Roman figures I., II., or III. denote from which Lead the tracing is obtained.

millimetres deflection. The resistance of this fibre ranges from about 3000 to 5000 ohms.

Each time the heart beats a wave of contraction passes along a definite path through the cardiac muscle. The impulses which set up these contractions arise normally at a definite point of the heart muscle, near the opening of the superior vena cava into the right auricle, known as the sino-auricular node. From this node the impulse travels along unknown paths through the auricular muscle to another node of specialised tissue situated at the opening of the coronary sinus, called the auriculo-ventricular node. Here a definite band of muscle fibre begins, namely the auriculo-ventricular bundle of His, which conveys the impulse from the auricles to the ventricles. This bundle, near its commencement, divides into two main branches; one of these branches passing to the right ventricle, the other piercing the ventricular septum, and further sub-dividing into two divisions to reach the left ventricle. From this it is evident that a single beat of the heart really consists of a contraction of the two auricles, followed by a contraction of both ventricles.

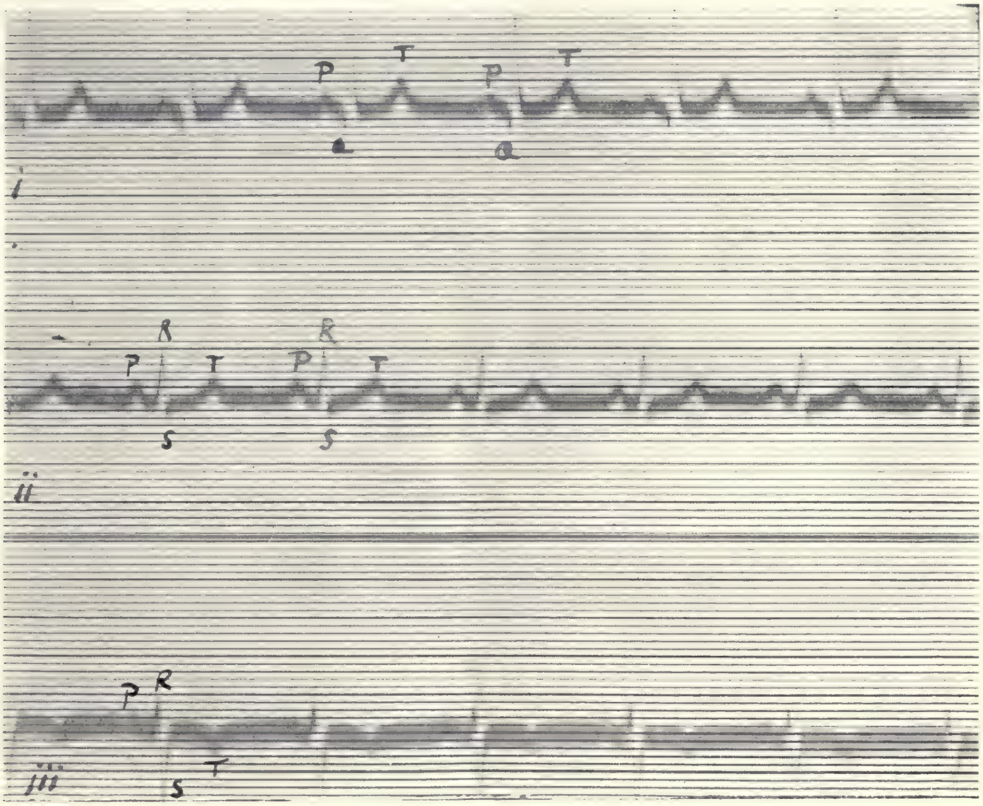


FIG. 2.—This electrocardiogram shows left ventricular preponderance.

If one studies an electrocardiographic record of a single contraction of the heart, one can usually distinguish four, or possibly five, deflections. These five waves are labelled empirically P, Q, R, S, and T. Of these waves only the first, or "P" wave, is caused by the contraction of the auricles, the other waves all occur during ventricular systole.

Not uncommonly the "Q" wave is entirely absent, and the depth of the "S" wave is also very variable. The P, R, and T waves should be in an upward direction, but the "Q" and "S" waves are downward deflections. In carrying out experiments upon the hearts of animals, it has been possible to place the electrodes directly upon different parts of the heart muscle itself. In the human subject, however, this is obviously impossible; but it is found that when the electrodes are placed upon the surface of the body, the cardiac impulses can be conveyed equally well provided that any current generated from the skin is previously eliminated.

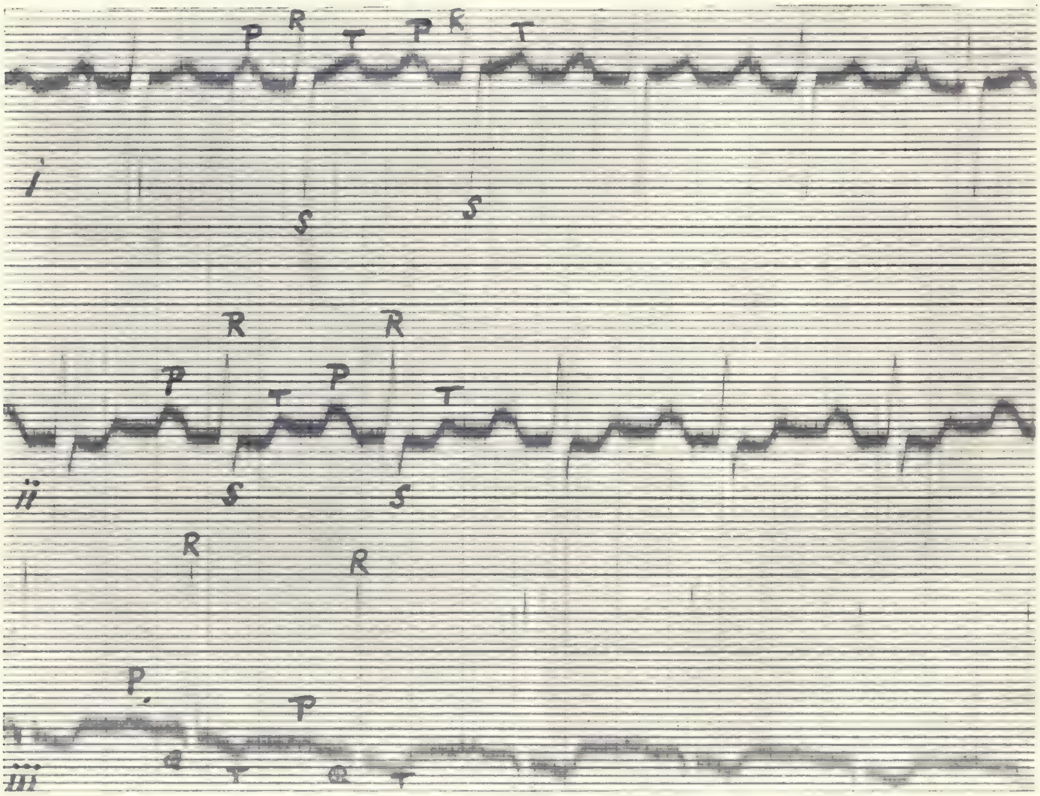


FIG. 3.—An electrocardiogram illustrating right ventricular preponderance.

Clinically it is customary to use three non-polarisable electrodes, which are placed, one upon each forearm and one applied to the left leg. When any two of these electrodes are fixed to the patient and connected to the galvanometer, the usual deflections previously described can be obtained. It is usual to take three different tracings from each patient:—

1. With both arms in circuit with the galvanometer. (Lead I.)
2. When the right arm and left leg are in circuit. (Lead II.)
3. When the left arm and left leg are in circuit. (Lead III.)

If these three leads from a normal subject are studied, the following main features can be seen in Figure I.:—

a. The highest "R" wave is seen in Lead II.
b. The P-R or P-Q interval should be less than one-fifth second.
c. The time elapsing between the commencement of the R and S waves should be not longer than one-tenth second.
d. The Q, R, S, and T period should be approximately one-third of the complete cardiac cycle.

In considering the diseases of the heart, it is clearly seen from the early part of this article that the electrocardiograph will be of greater value in diagnosing changes in the heart muscle than in valvular disease of the heart. As, however, most of the valvular affections cause some change in the muscle as well, the electrocardiograph may sometimes be of value, indirectly, in the diagnosis of such conditions.

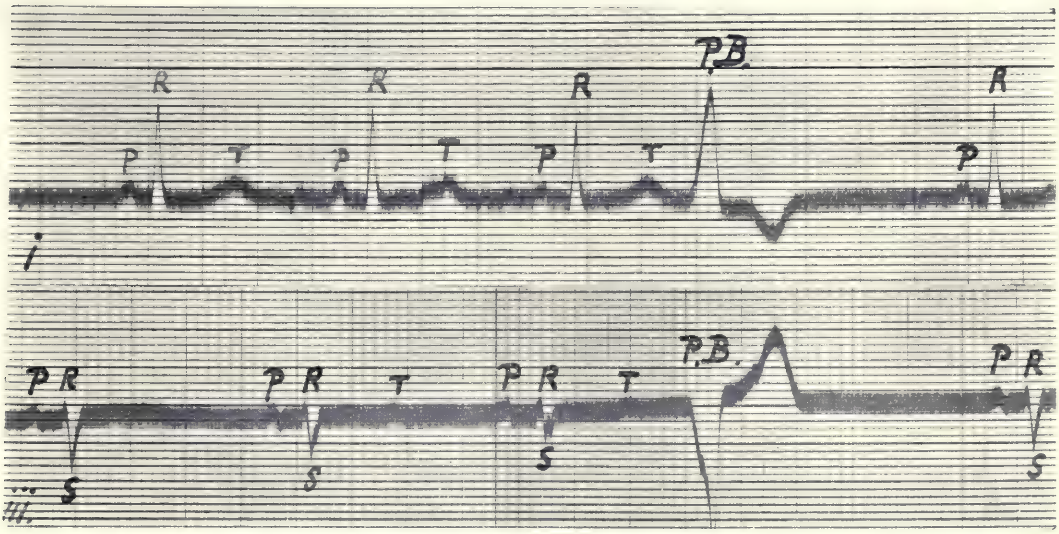


FIG. 4.—This electrocardiogram shows premature contractions arising near the apex of the left ventricle. Each abnormal beat is labelled P.B.

In order to classify the pathological conditions of the heart, I shall describe the more common electrocardiographic records from—

A. Cases in which the ventricular muscle is changed.
B. Cases in which the auricles are diseased.
C. Cases in which the connecting link between the auricles and the ventricles, namely, the auriculo-ventricular bundle, is involved in a general myocardial degeneration process, or where it is damaged locally.

In the normal human heart, the weight of muscle of the left ventricle compared to that of the right ventricle is approximately in the proportion of 1·7 to 1. When either ventricle becomes hypertrophied this ratio is altered. This will cause characteristic changes in the electrocardiograms. If, however, both ventricles are hypertrophied the ratio 1·7—1 may be unchanged. Under such conditions the electrocardiogram will not necessarily differ from the normal.

If the left ventricle becomes hypertrophied, the highest "R" wave will no longer be found in Lead II. but in Lead I., and in Lead III. the "R" summit will be short, and will be followed by an abnormally steep "S" wave. Lead III. will look very much as though it had been turned upside down. These characteristic changes are well seen in Figure 2.

Hypertrophy of the right ventricle causes exactly the opposite condition. The highest R summit is seen in Lead III., whereas the short R and steep S waves are found in Lead I.

The tracings described above have all been taken from cases in which not only has the path of conduction of the cardiac impulse been normal, but also the ventricular muscle has been healthy. It is now necessary to consider cases where the impulses have not arisen at the sino-auricular node, and also cases where there is degeneration of the ventricular muscle.

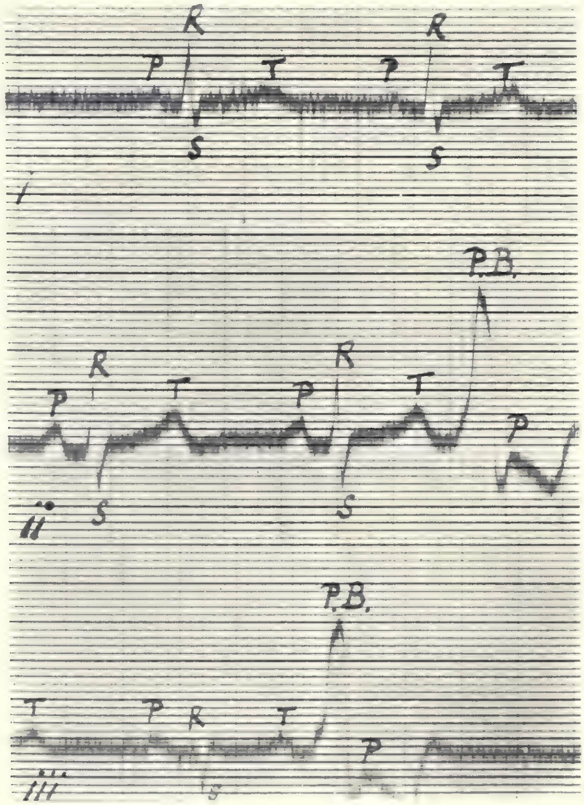


Fig. 5.—This electrocardiogram shows a premature ventricular contraction in Lead II., and another in Lead III. Both these beats, which are marked P.B., have arisen near the base of the ventricle.

Any portion of the heart muscle can, under certain conditions, set up a contraction spontaneously. Such a contraction is usually called an extra systole, and it may be either auricular or ventricular in origin. The term extra systole is an unfortunate one, because it implies an additional contraction, whereas in reality an extra systole is not an extra beat but a premature beat. The mere fact that a patient is getting occasional premature ventricular contractions does not necessarily imply that there are actual degenerative changes in the muscle, but that there may be increased irritability of the heart muscle. It is not an uncommon experience to find these premature beats occurring during attacks of flatulence, or possibly in people who smoke strong tobacco, though there may be nothing to suggest any reason for myocardial degeneration. On the other hand, many people whose heart muscle has certainly undergone degenerative changes, either fatty or fibrous, are liable to get premature contractions at frequent intervals. The appearance of premature ventricular contractions in an electrocardiogram is quite different from that of normal ventricular contractions which have originated at the sino-auricular node. No standard type of wave exists which denotes one of these abnormal beats, for different kinds of waves occur according to the site of their origin. There are, however, certain features characteristic of premature ventricular contractions:—Each premature beat causes two well marked deflections, which are always in opposite directions. The first is usually the larger and more abrupt wave, the second being shorter and rather more blunt. The tracings of these abnormal beats are very much alike in Leads II. and III., but are usually exactly the reverse in Lead I.

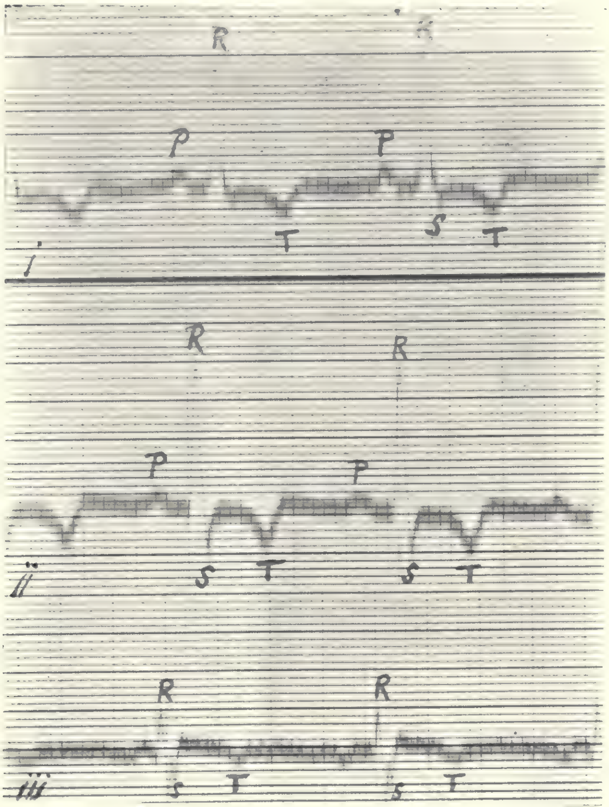


Fig. 6.—Electrocardiogram showing inversion of the T waves in all leads.

It would be impossible to describe all the different types of waves which might occur as a result of these premature beats. I shall only describe two kinds:—(1) Premature ventricular beats arising spontaneously near the apex of the left ventricle, and (2) similar beats arising near the base of the right ventricle.

When a premature beat arises near the apex of the ventricle, the electrocardiogram will show first an abrupt summit, followed by a smaller downward wave in Lead I., whereas Leads II. and III. will show an abrupt downward wave, followed by a less abrupt summit.

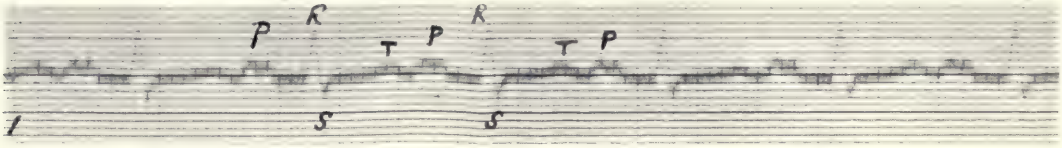


Fig. 7.—Marked notchings of the P waves from a case of mitral stenosis.

Premature beats arising near the base of the ventricle cause exactly the opposite appearance. The first wave in Lead I. is downward, and the second deflection in a upward direction, and *vice versa* in Leads II. and III.

In all cases where premature ventricular contractions occur, the auricular rhythm is unaffected and therefore quite regular. One would therefore expect to find a regular sequence of P waves in the electrocardiogram. Sometimes this can be done quite easily, but more often the ventricle contracts simultaneously with the auricle, in which case the ventricular waves may either mask or completely obliterate the auricular wave.

The diastolic pause, during which the heart muscle is resting, is always longer after a premature beat than after a normal beat, thus compensating for the short pause immediately before the abnormal beat.

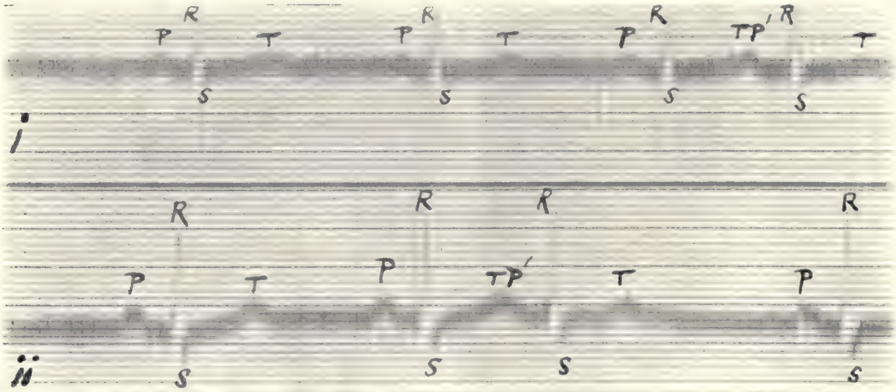


Fig. 8.—Premature auricular beats, marked P′, seen in Leads I. and II.

I shall now endeavour to describe yet another condition in which the disturbance is found to occur in the ventricular waves. The only abnormality seen in the electrocardiogram is the inversion of the "T" waves in all the three leads. It is not uncommon to find the "T" wave inverted in Lead III. in many individuals in whom no cardiac disease is either suspected or found, but if the "T" waves are inverted in all three leads, it is, in my opinion, indicative of some myocardial change. I have seen several cases which showed this inversion of the "T" waves, and in any of these cases which died, where an autopsy was made, degenerative changes of the heart muscle were always evident.

Passing on to the changes which may occur in the auricle, several conditions must be described.

In many cases of stenosis of the mitral valve of the heart, where there is no abnormality in the path of conduction of the impulse, it is common to find the "P" waves either very high or distinctly plateau-shaped. The summits of each of these plateaux often show a well marked notch.

In describing premature contractions previously, I mentioned that any portion of the heart muscle could set up a contraction spontaneously. When these abnormal beats occur in the auricles, the normal sequence of "P," "Q," "R," "S," and "T" waves is suddenly interrupted by the appearance of a premature "P" wave. If this abnormal contraction is set up very prematurely, it is probable that the auricular beat will occur while the preceding ventricular contraction is still in progress. This would show itself in an electrocardiogram by the premature "P" wave being either superimposed upon, or immediately following the preceding "T" wave.

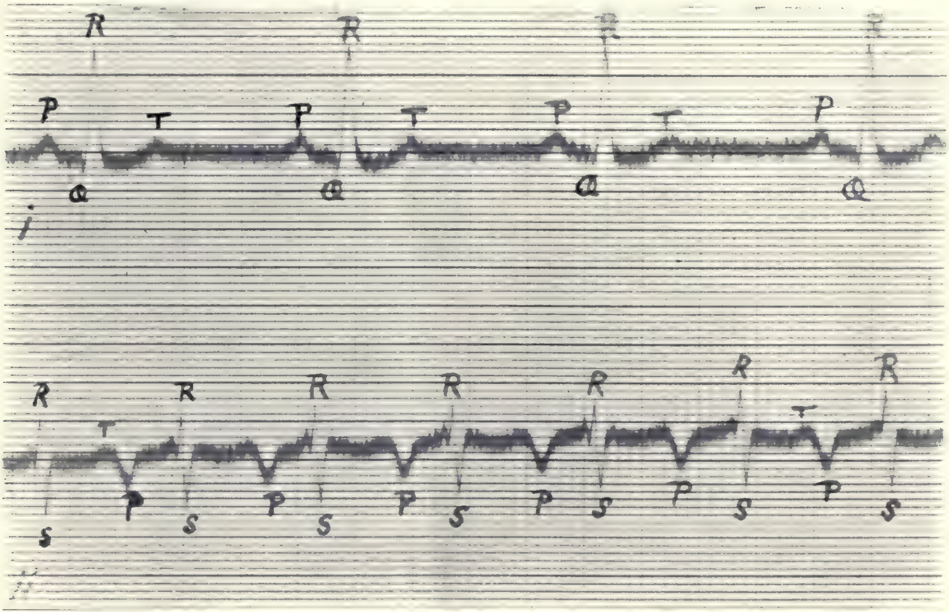


Fig. 9.—An electrocardiogram taken from a case of Paroxysmal Tachycardia. The rate in Lead I. is 64 beats a minute, but in Lead II. it has suddenly risen to 120. Note the inversion of the auricular waves during the period of Tachycardia.

Now each time an impulse arises prematurely in the auricles, it passes through the auriculo-ventricular bundle in the usual manner, thus giving rise to a ventricular response which must, therefore, also occur prematurely. As, however, the ventricle has received its stimulus through the normal channel, the ventricular complex "R," "S," and "T" will show the usual appearance, and will not resemble in any way a premature contraction which has originated in the ventricular muscle.

After each premature auricular contraction there will be a longer pause than normally after the "T" wave, but this long pause is not so long as one which follows a premature ventricular contraction, therefore it does not fully compensate for the short pause immediately preceding the abnormal beat.

A condition probably closely allied to that of premature auricular contractions is one known as Paroxysmal Tachycardia. It is well known that in normal individuals the rate of the cardiac rhythm is very definitely increased by exertion, and in some people markedly so. In individuals who are of a somewhat nervous temperament the heart very easily becomes rapid in its action. In such cases, although the acceleration of the cardiac rhythm often begins abruptly, the return to the normal slower rhythm is a gradual process. In Paroxysmal Tachycardia, however, not only do the paroxysms of tachycardia commence suddenly, but they end equally abruptly by returning to the normal cardiac rhythm.

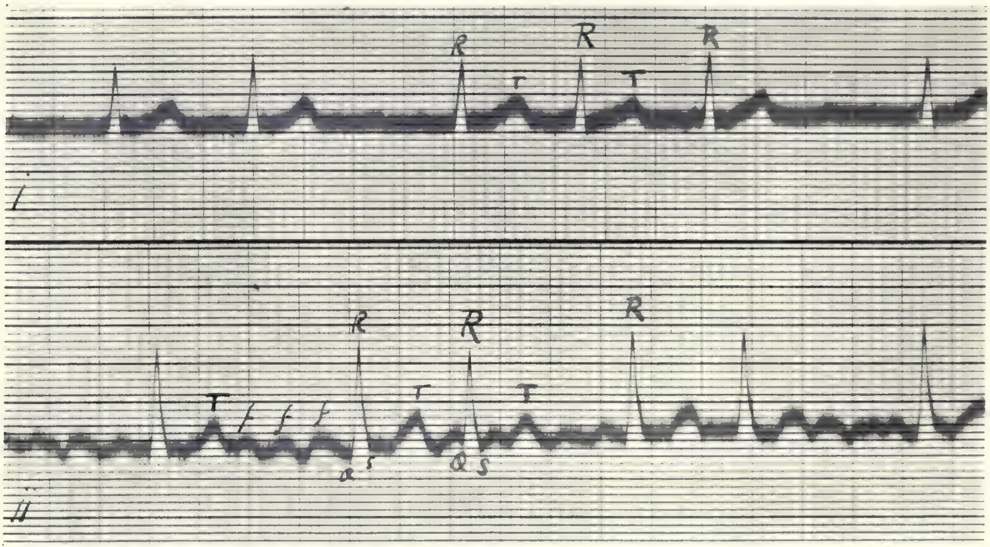


FIG. 10.—A typical tracing of Auricular Fibrillation. The smaller oscillations marked "f" are probably due to the actual fibrillations of the heart muscle.

By some authorities this condition is regarded as a series of premature auricular contractions occurring at a very rapid rate. In favour of this view that the disturbance is in the auricle rather than the ventricle, it has been shown that after the paroxysm has passed, that is to say, when the rhythm has returned to about 80 beats a minute, the regular cardiac rhythm is not infrequently disturbed by the occasional appearance of auricular premature contractions. Again, many electrocardiograms from cases of paroxysmal tachycardia show inversion of the "P" waves during the paroxysm, though they appear as normal "P" summits when the normal rate is reached.

Of all the varieties of cardiac irregularity, the condition known as Auricular Fibrillation is certainly the most common. This condition occurs in young adults as a complication of rheumatic fever, especially in those cases where the mitral valve of the heart has become stenosed as a result of the rheumatic infection. It also occurs in older people, about 50 to 60 years of age, when it is usually associated with some fatty or fibrous degeneration of the heart muscle. In Auricular Fibrillation, the auricles no longer contract rhythmically, but the individual fibres of the auricles are contracting and relaxing alternately at an extremely rapid rate. Only comparatively few of these fibrillary contractions are sufficiently powerful to set up any response in the ventricles. There is, therefore, no longer a regular series of impulses passing from the auricles through the auriculo-ventricular bundle to the ventricles, consequently the ventricular systoles occur very irregularly.

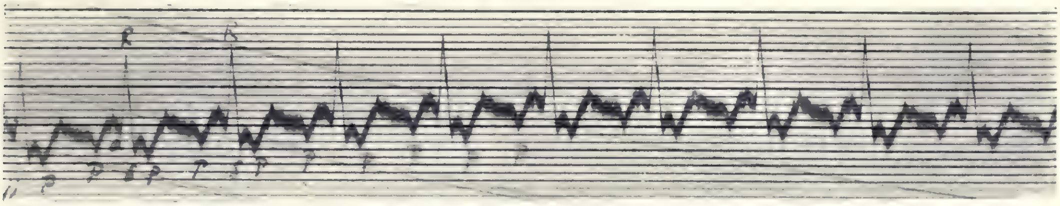


Fig. 11.—This electrocardiogram illustrates the condition of Auricular Flutter. The ventricles are contracting about 140 times a minute, but the auricular rate is exactly double.

Electrocardiographic records obtained from such cases show several characteristic features. First there is complete absence of any "P" waves; secondly the ventricular complex "R," "S," and "T" occurs at very irregular intervals; thirdly in some of the longer diastolic pauses, several small oscillations can usually be seen, which are probably due to the actual fibrillary contractions themselves.

A condition closely allied to that of Auricular Fibrillation is one known as Auricular Flutter. Here one finds that the auricles contract very rapidly, namely between 260 and 320 times per minute. The ventricles, too, beat rapidly, but not nearly so fast as the auricles. Often the ventricular rate is one-half or one-third of the auricular rate, or possibly partly one-half and partly one-third of the rate of the auricular systoles, thus giving rise to an irregular ventricular rhythm.

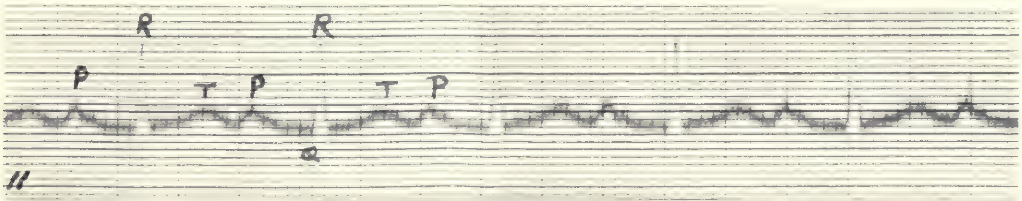


Fig. 12.—This tracing shows evidence of very slight heart block. The "P"—"R" interval is slightly more than one-fifth second.

A rather striking feature of this condition is that neither exercise nor rest seems to have any effect upon the ventricular rate. Many of these cases will, when treated with large doses of digitalis, change to a state of Auricular Fibrillation.

The last section of this paper will be devoted to conditions where the disease affects the auriculo-ventricular bundle, thus impeding the passage of the impulse from the auricles to the ventricles. Such a condition may be caused by general myocardial degeneration involving the bundle, or by some local disease in the bundle itself, such as a gumma.

I have already stated that in the normal human heart the time taken for the impulse to pass from the auricle to the ventricle should be less than one-fifth of a second. If it is more than one-fifth of a second there must be some degree of heart block.

In the earliest stage of heart block, the electrocardiogram merely shows an increase in the "P"—"R" interval.

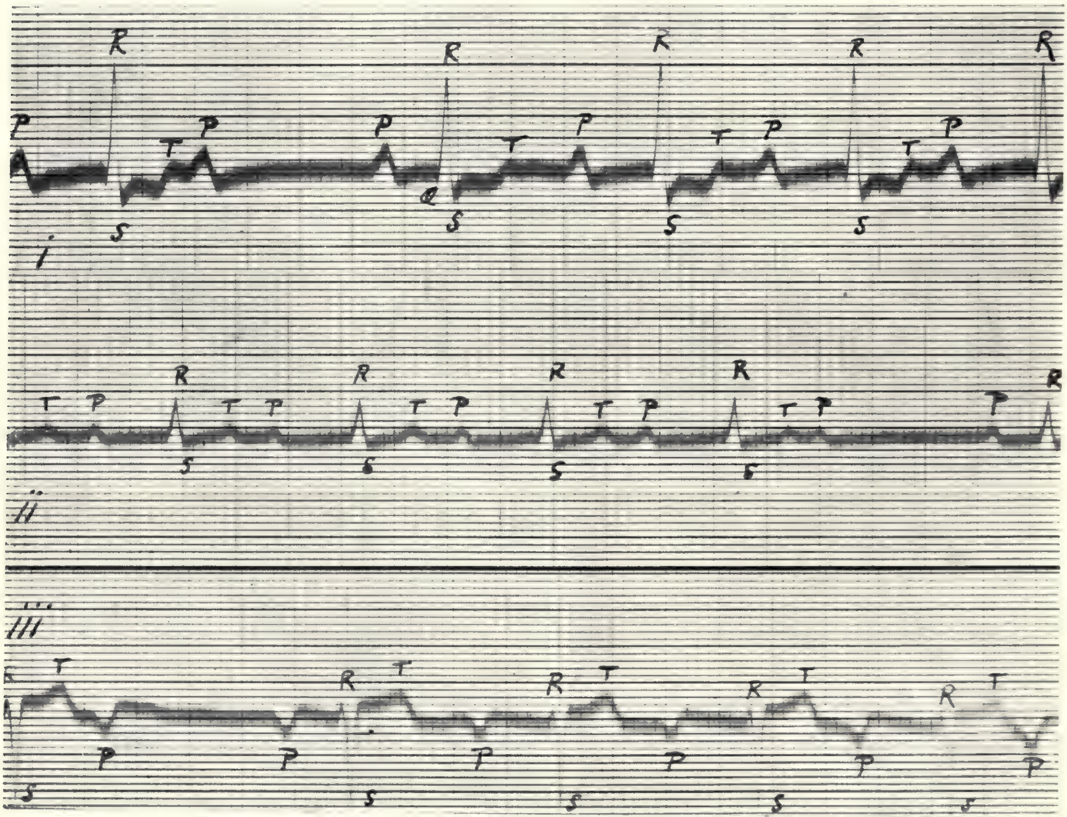


FIG. 13.—The stage of heart block where occasional ventricular beats are "dropped."

As the fibres of the bundle become more seriously damaged the delay in the passage of the impulse becomes more marked, until a stage is reached where the impulse occasionally fails to reach the ventricle, consequently no ventricular contraction occurs. This is usually spoken of as the stage of occasional "dropped beats." An electrocardiogram of such a condition shows a progressive lengthening of the "P"—"R" intervals, until a "P" wave is seen with no "R," "S," and "T" series following it. When this beat is "dropped" the ventricular muscle gets a longer period of rest than usual. As a result of this prolonged inactivity of the muscle, the irritability, or power of response to any stimulus, of the ventricle is increased. The impulse set up by the auricular contraction occurring immediately after the "dropped" beat will therefore not be delayed in setting up a ventricular response, hence the P—R interval after a dropped beat will not be prolonged.

As the degree of heart block increases, the ventricular beats are "dropped" more and more frequently, so that a time comes when every alternate ventricular beat is "dropped." This is called two to one heart block, because the auricles are beating twice as fast as the ventricles.

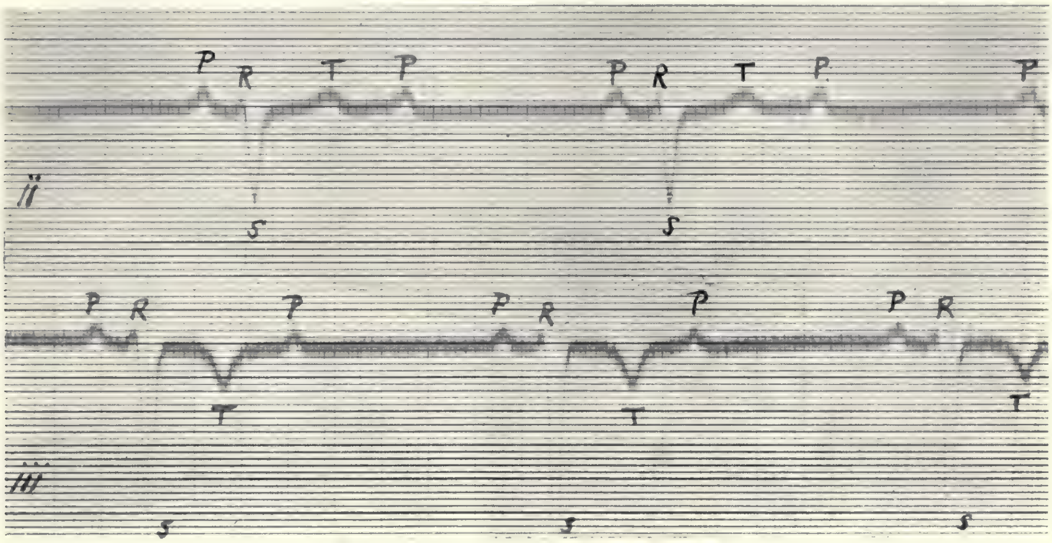


FIG. 14:—A case of 2:1 heart block.

Sometimes the auricle beats three or four times as fast as the ventricle, giving a condition of 3 : 1 or 4 : 1 heart block. It is therefore evident that numerous varieties of tracings can be obtained showing different degrees of damage to the bundle.

In the most severe form of heart block, no impulses are able to pass through the bundle at all. This is called complete heart block. Under these circumstances the auricles continue to contract at the usual rate of approximately 80 beats per minute, but the ventricles assume an entirely new rhythm of their own, contracting perfectly regularly between 30 and 40 times a minute. The ventricular beats bear no relation whatever to the auricular systoles, but are entirely ventricular in origin.

In concluding, I wish to thank all the Members of the Medical Staff of the Middlesex Hospital for so kindly allowing me to publish records of their cases. I am also greatly indebted to Dr. Sidney Russ for his valuable assistance whenever any difficulties occurred in working the Electrocardiograph.

GAS IN THE TISSUES.

By J. M. Woodburn Morison, M.B., C.M.,

Hon. Radiographer Ashton-u-Lyne. and District Infirmary. Late Radiographer Liverpool Merchants' Mobile Hospital, France.

In the course of my work as radiographer to the Liverpool Merchants' Mobile Hospital, I was able on many occasions, by X-ray examination, to demonstrate the presence of gas in the tissues in association with injuries caused by pieces of shell casing or metal with ragged edges. In all these cases it was found that the metal had carried into the tissues shreds of clothing which were found in the track and adhering to the ragged edges of the metal.

The clothing of the men coming from the trenches was caked in many places with earth, and in this way anaerobic gas forming bacilli were carried deep into the tissues.

Where pieces of metal were found, localised and removed, and no gas or pus had formed, the wounds were clean, and no clothing had been taken into the tissues. This often occurred in the face and hands. The rifle bullet, with its pointed end and smooth surface, made, as a rule, a minute entrance wound, and carried in no clothing. In these cases no gas forming bacilli gained entrance. In one case, however, there was gas formation in association with a rifle bullet.

The bullet was a ricochet, all the lead had been expelled and only the twisted metal casing, with sharp edges, had entered the flesh.

In the X-ray examination of these cases, with a large fluorescent screen and the diaphragm "stopped down," the bubbles of gas could be seen. I found, however, that the best view was obtained with a small screen, as it did away with the slight fluorescence around the "stopped down" area on the large screen. The screen I used was the Thurstan Holland localising one, which has also the advantage of being easily fitted to any part of the body.

The cases investigated could be divided into two groups :—

1. Cases of true gas gangrene.
2. Cases of localised gas formation.

Group 1 : True gas gangrene.—In these cases the gas formation was exceedingly rapid, spreading along the muscle sheaths, and finally leading to complete disintegration of the muscles. The quantity of gas evolved was considerable, the part affected being swollen and so tense that the gas could be heard escaping when an incision was made. The smell of the gas was indescribable, and in advanced cases a diagnosis could be made without an X-ray examination. As amputations had to be done in many of these cases, the X-ray plates were often of value as evidence of the necessity of the operation, especially in cases where the original injuries were not of themselves serious.

Group 2 : Localised gas formation.—Here I found that the gas formed in the vicinity of the metal and collected in bubbles of varying size—forming slowly and not exhibiting the same tendency to spread along the muscle sheaths. It

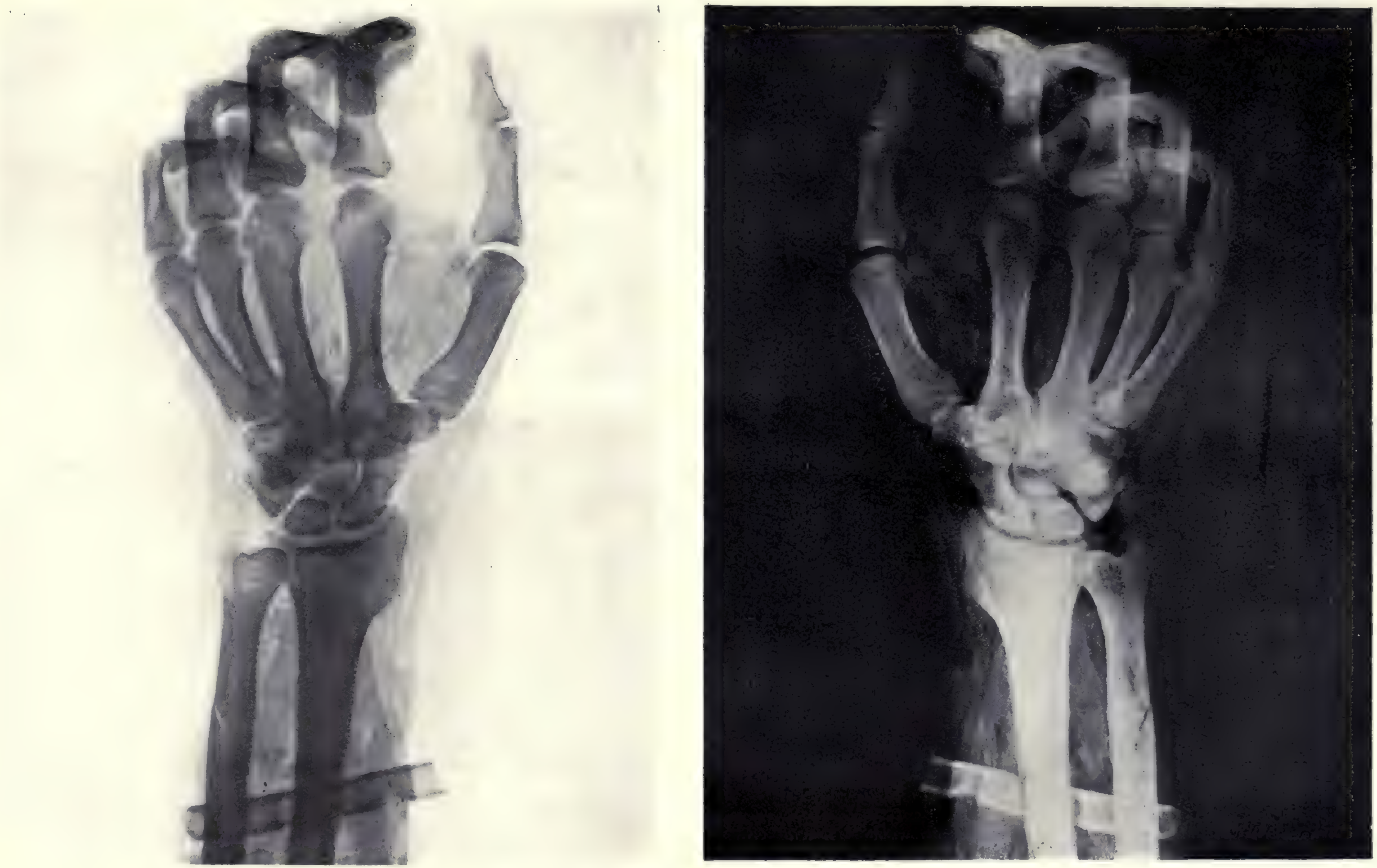
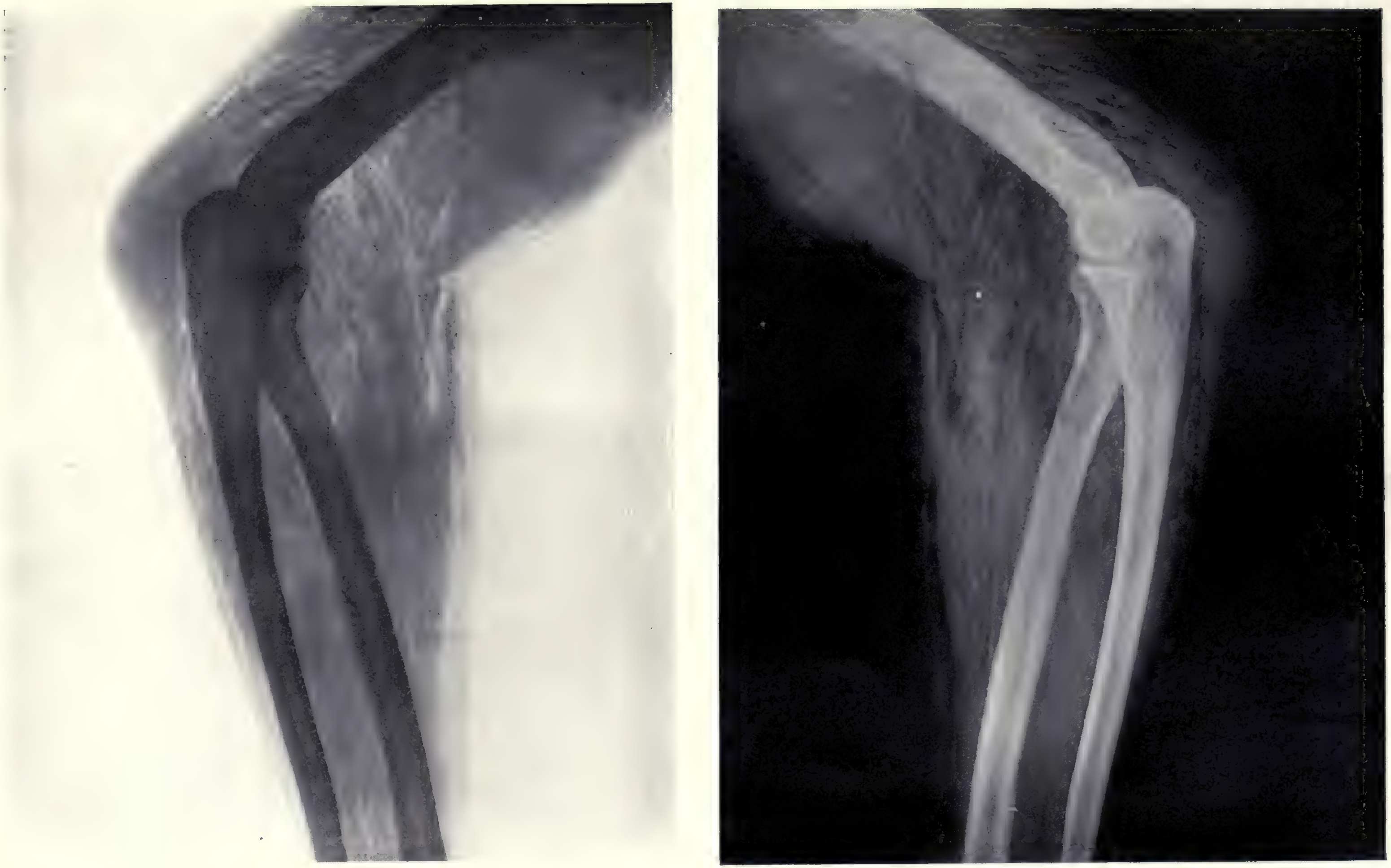


PLATE 27.

RADIOGRAMS OF GAS GANGRENE.

FIG. 1.—Advanced case of gas gangrene, showing disintegration of muscles.



RADIOGRAMS OF GAS GANGRENE.

PLATE 28.

FIG. 2.—Gas gangrene, showing the course of the gas along the muscle sheaths.

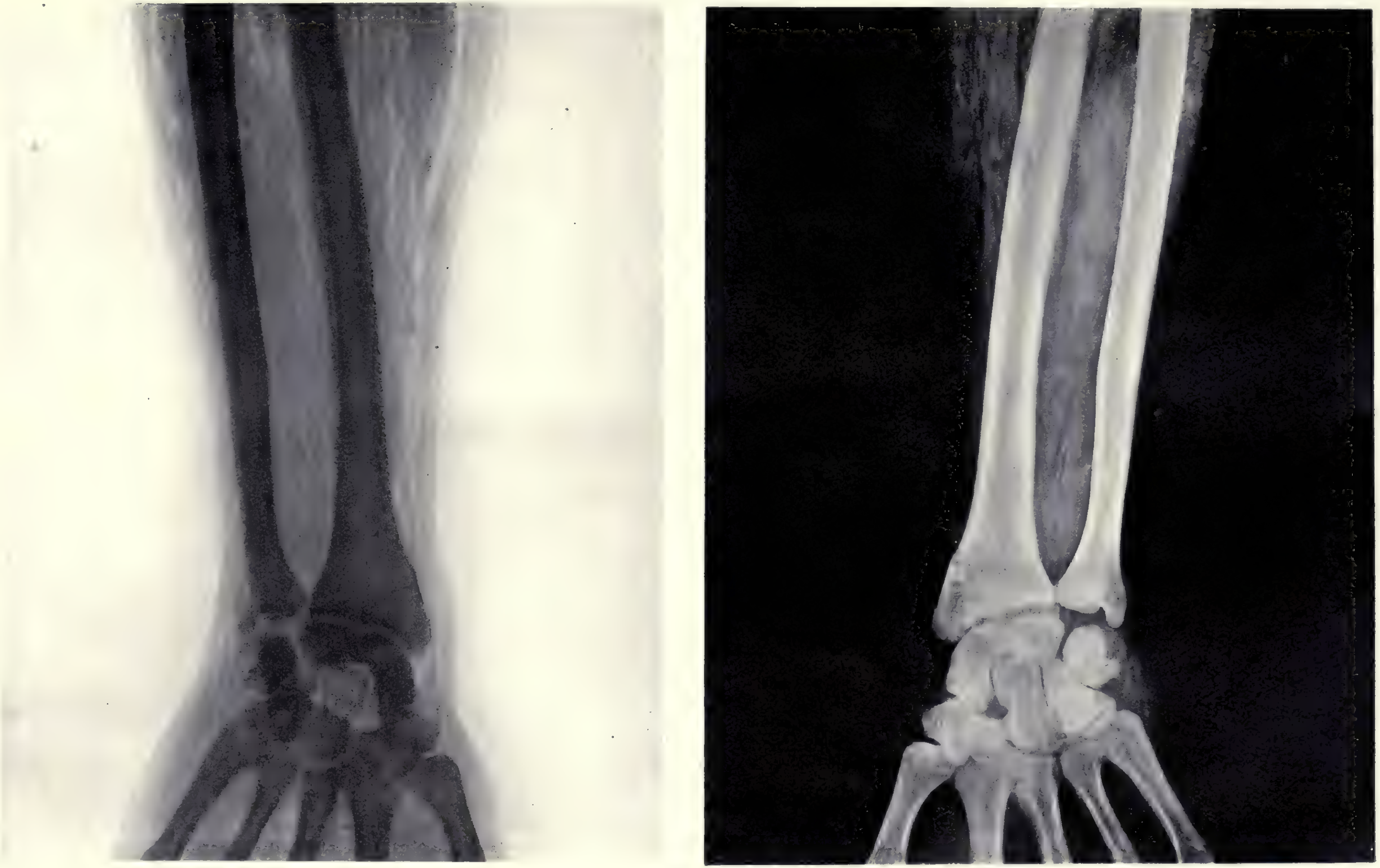
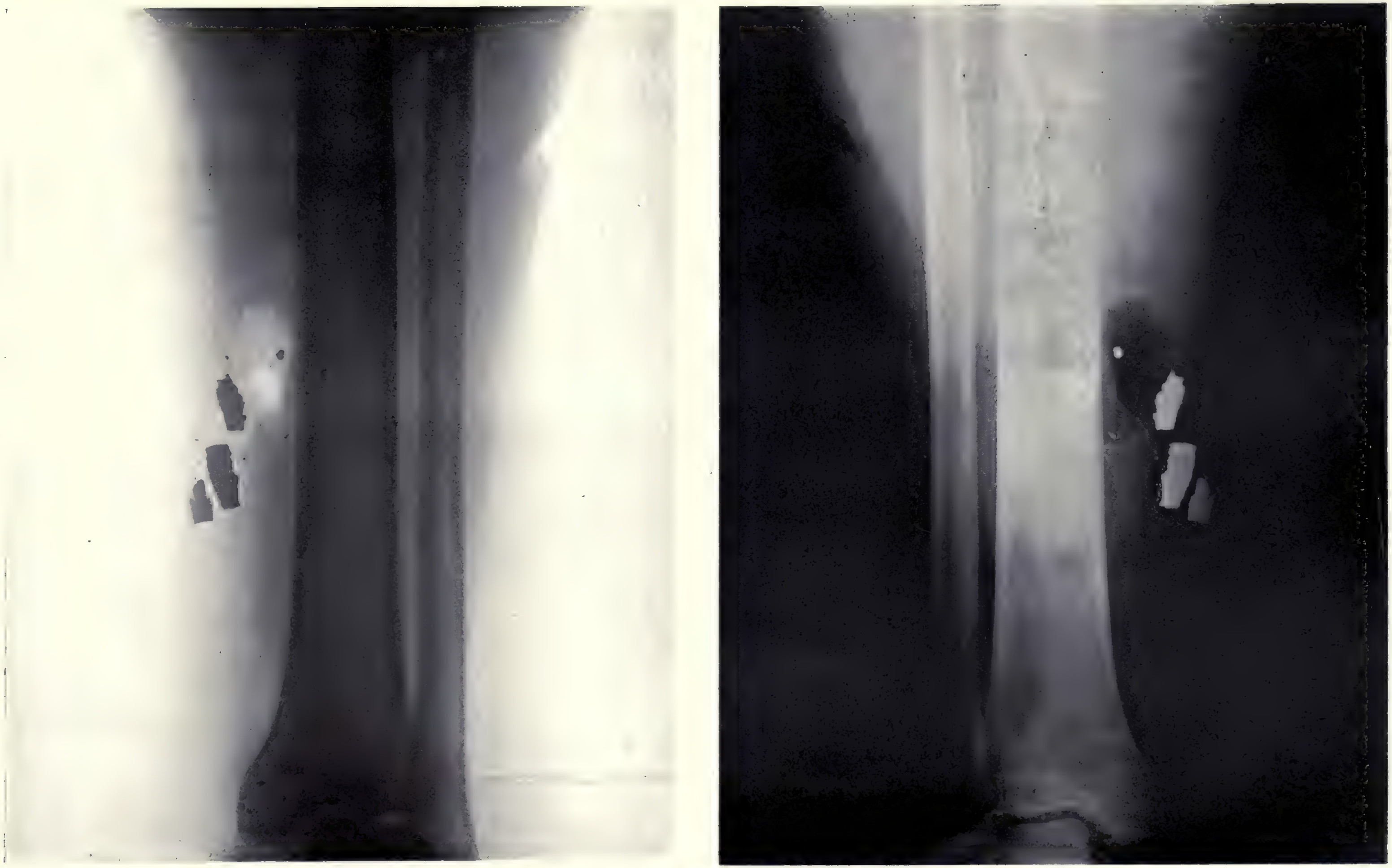


Plate 29.

RADIOGRAMS OF GAS GANGRENE.

Fig. 3.—Gas gangrene in an earlier stage.



RADIOGRAM OF GAS BUBBLE.

PLATE 20.

FIG. 4.—Gas bubble in the vicinity of shell casing.

was possible to demonstrate its presence in minute quantity long before it could be diagnosed otherwise than by X-ray examination.

The early detection of the presence or absence of gas in the tissues is important. If present surgical interference is at once indicated, and if absent one point at least has been established in favour of leaving well alone. I found that even a negative X-ray diagnosis could be made with some degree of certainty and was regarded as valuable to the surgeon.

THE ALTERNATING CURRENT FROM THE PUBLIC MAINS IN THE TREATMENT OF NEURITIS AND MUSCULAR ATROPHY.

By **Prof. H. Bordier, Lyons.**

The alternating electric current has been in use for some time for the treatment of certain diseases. (d'Arsonval, Bergonié, Labatut, etc.) Up to the present time, however, the ordinary industrial alternating current has not been systematically employed for therapeutic purposes. During the present war, in the treatment of the wounded, many of whom suffer from neuritis, atrophy, or paralysis, it became most important to determine whether this current could be utilized, since it was usually installed for the lighting in military hospitals, and was generally the only form of electric current available. It was a case of this or none.

Since September, 1914, I have had an opportunity of studying the physiological and therapeutic effects of the alternating current in three of the largest hospitals, those at Ecully, Saint Genis Laval and Charbonnières. The current used was at 110 volts with a periodicity of 50 per second.

The first requisite for utilizing this current was some means of regulating its intensity and increasing it gradually from zero. There are, of course, numerous forms of apparatus designed for this purpose. The simplest of these—and simplicity is of vital importance in army work —is the Chloroform Bottle-Rheostat, which I described in *La Presse Médicale* (Oct., 1914), and in the *Journal des Practiciens* (Feb. 4, 1915). This is a most convenient form and can be improvised on the spot by anyone, anywhere, thus greatly simplifying the necessary apparatus.

I. Muscular Atrophy.—For the treatment of Muscular Atrophy the alternating current should be rhythmic in character. There are three methods by which this can be obtained.

a. The Roller Electrode.—The indifferent electrode is placed at the proximal end of the affected limb, or on the back. The roller, which should be of some spongy material well soaked in warm water, is slowly passed up and down over the affected muscles. The rhythmic alteration of intensity obtained in this manner is very irregular, but nevertheless it is most effective, the muscles passing alternately through periods of contraction and repose.

b. The Metronome.—This instrument gives a very regular rhythm. It has, however, the disadvantage of making and breaking the current very sharply. As the metal pointer plunges into the mercury the current passes with its full intensity, and this is maintained until the instant when the pointer is withdrawn.

c. The Rheostat Interrupter.—This instrument, designed by me in 1903,* has proved of the greatest value in my electrotherapeutic practice. I have repeatedly proved its superiority over the metronome. It gives a rhythmic effect which is very regular, and moreover slow and progressive. The dipping carbon rod, terminated by a pencil of glass wool, is moved up and down by clockwork. The current thus increases gradually until the carbon reaches its lowest point, and then gradually decreases until the carbon is entirely removed from the water again. The muscular contractions set up by this current are gradual; there is no sudden shock, as when a metronome is used. They arise and fade away slowly, thus resembling closely the natural voluntary contractions. This is clearly shown in the graphs published by me in the *Archives d'Électricité Médicale*, 1903, p. 491.

The physiological effects of the industrial alternating current are quite distinct from those of the Faradic current. With the alternating current we get in addition the periodic variation and alternation of direction of the current, whereas with the Faradic current the quantity only can be varied.

II. NEURITIS.—The factor which determines the chemical changes in the various tissues is the quantity, rather than the character of the current. With an alternating current we get no true electrolysis, in the sense that no free ions are liberated within the tissues. There is, however, a continual displacement of the ions. It is this movement and displacement of ions to which we must attribute the increased cellular combustion observed by d'Arsonval. This acceleration of all acts of nutrition and more particularly the increased oxidation occurring in all cells traversed by the current renders the alternating current a most efficient therapeutic agent in the treatment of Neuritis, even when there is present the reaction of degeneration. (R.D.)

In the treatment of Neuritis, whether R.D. is present or not, the alternating current should be kept steady, no rhythmic device being used. The affected limb may be immersed in warm water, the current being conducted to the bath by means of a carbon plate. The other electrode is placed over the affected nerve, above the seat of the lesion. The bottle rheostat must be carefully adjusted so that the current shall be very weak, not sufficient to produce muscular contraction. The current intensity should be tested on the operator as there is no efficient means of measuring this form of current.

PRACTICAL ADVANTAGES OF THE INDUSTRIAL ALTERNATING CURRENT.—Not the least of the advantages of this form of current, especially when it has to be employed by hospital orderlies, is the impossibility of producing burns or scars, such as we sometimes get with the continuous current. If by accident the intensity should be too great, the utmost result will be a slight erythema and reddening of the skin under the electrodes.

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* *Archives d'Électricité Médicale*, 1903, page 489.

The sensation of the alternating current is not painful when the current is weak. Even with the greater intensity necessary to provoke contraction in atrophied muscles, the periodic intervals of rest obtained with the rhythmic rheostat render the prickling sensation quite bearable. It is, moreover, found that with this rheostat-interrupter the ordinary electric sensation is much less intense than usual.

Another advantage is that the alternating current can also be used to diagnose the presence of the Reaction of Degeneration. For this purpose the excitation must be localized by using a very small electrode. The muscle or nerve is first tested on the unaffected side. The electrode is placed on the motor point, and the current is gradually increased by means of the Bottle Rheostat until contraction just commences. The electrode is then transferred to the same point on the affected side.

(*a*) The contraction takes place with the same intensity of current. There is no R.D.

(*b*) The contraction only appears after the intensity of the current has been much increased. There is partial R.D., Duchenne's reaction.

(*c*) No contraction is obtained even with the maximum current. There is complete R.D.

The advantage of being able to test the muscle without the use of additional apparatus is obviously of great importance. Moreover, with the alternating current the re-integration of the nerve and the nervous influx is much more rapidly re-established than with the Faradic current. At the same time the nutrition of the affected muscle is more rapidly improved, since the atrophy is overcome more quickly than when Faradization alone is employed. This opinion is the result of a long series of observations of the application of the alternating current to wounded soldiers.

We would therefore recommend, when installing a new military hospital, that wherever both constant and alternating mains are available, the latter should invariably be chosen.

PROFESSOR BERGONIÉ'S ELECTRO-VIBREUR

Dr. Ettie Sayer.

Bergonié's Electro-Vibreur, although not yet established in this country, has met with great appreciation from French surgeons, and has been officially generalised for use in the French army.

It consists of a coil, made of a bundle of iron wire wound round with copper wire. When being charged with an alternating current it sets up induced currents in any fragments of metal in its neighbourhood, thus causing them to vibrate. If the fragments are embedded in the flesh, and an examining hand is laid flat over the part, a vibration will be transmitted to the hand from the fragment as an assistant approaches the Vibreur. This vibration is very distinct and characteristic, and leaves no manner of doubt about it, but enables accurate localization to be easily made, both before and during the operation.

The method has its limitations, but for cases which fall within these limitations it is superior to any other help available to the surgeons. *Its advantages are as follows :*

(1) *Its extreme simplicity and practicability.*—Any surgeon can become personally expert in its use in half an hour.

(2) *Short incisions.*—These need to be only just large enough to insert the extractor.

(3) *Rapidity of extraction.*—The Vibreur (wrapped in a sterilized cloth) can be approached to the wound as often as the surgeon wishes. Owing to the help obtained from being able to re-inform himself of the exact localization continuously during the operation, I have seen numerous extractions done in France in a few seconds, which comparison with similar cases done without a Vibreur lead one to suppose would have otherwise taken a quarter to half an hour.

(4) *Local Anæsthesia.*—The above rapidity renders novocaine and adrenalin quite sufficient in a large percentage of cases.

(5) *Particles so minute and multiple*, that their extraction would be so difficult as to be practically impossible with any other method, are quite easily removed with a Vibreur.

(6) It relieves the radiologist of a vast amount of monotonous photography of simple cases, but leaves him with the interest of the difficult ones and the fractures, etc.

The Intensity of Vibration depends :

(1) *On the constitution of the fragment.*—It is most marked from the magnetic metals, but is also very marked from many non-magnetic ones, the intensity depending on the product of their density and resistance. Aluminium, copper, and silver are easily felt, zinc with difficulty, and lead not at all. In actual practice this works out that the Vibreur can be used for 95 per cent. of the projectiles used in this war.

The following is a table copied from an article by M. Bergonié in the July number of the *Archives d'Électricité Médicale*, illustrating the vibratibility of the non-magnetic metals.

Metal	Density	Resistance	Product
Al.	2·56	2·90	7·42
Cu.	8·95	1·58	14·14
Ag.	10·40	1·46	15·18
Au.	19·34	2·	38·68
Qu.	7·16	5·61	40·16
Su.	7·29	13·18	96·08
German Silver	8·43	20·89	176·10
Pt.	21·5	9·0	193·5
Pl.	11·34	19·14	217·04
Sc.	6·70	35·4	237·18
Hg.	13·59	94·07	1278·41

(2) *On the strength of the Vibreur.*—These are manufactured to work on alternating mains of 110 or 220 volts, and various periods. The charge must not be below 3 kilowatts (30 ampères on 110 volts at about 50 periods). For the more difficult of the above metals it has to be 6 or 7 kilowatts.

(3) *On the position of the fragment.*—(*a*) In muscles. Vibration is transmitted best from fragments situated intramuscularly. (*b*) Lung. Lung tissue conducts very badly. Nevertheless, several French surgeons have recorded cases of successful removal from the lung with the Vibreur. (*c*) Bones. If embedded in a small bone, the whole bone will vibrate throughout its length. If in a large bone, nothing is felt. If caught in a notch of a vertebra so that movement is impossible, nothing will be felt.

The instrument is made by Messrs. Gaiffe.

NEW INSTRUMENTS.

NEW APPARATUS FOR THE LOCALIZATION OF FOREIGN BODIES.

By Rupert Hallam, M.D., Ch.B.
(Major R.A.M.C.T.) 3rd Northern General Hospital, Sheffield.

In view of the numerous descriptions of methods of localizing foreign bodies, which have appeared in the medical press during the last year, it is with some diffidence that I attempt to describe a system which, in principle, has no claim to originality, but yet may, I believe, rightfully be described as accurate, rapid, and simple to work. It has the advantage that it provides a stereo-negative from which also the depth of the foreign body may be determined. The tube may be used above or below the couch.

The designing of the necessary apparatus was undertaken in the X-ray department of the 3rd Northern General Hospital, with a

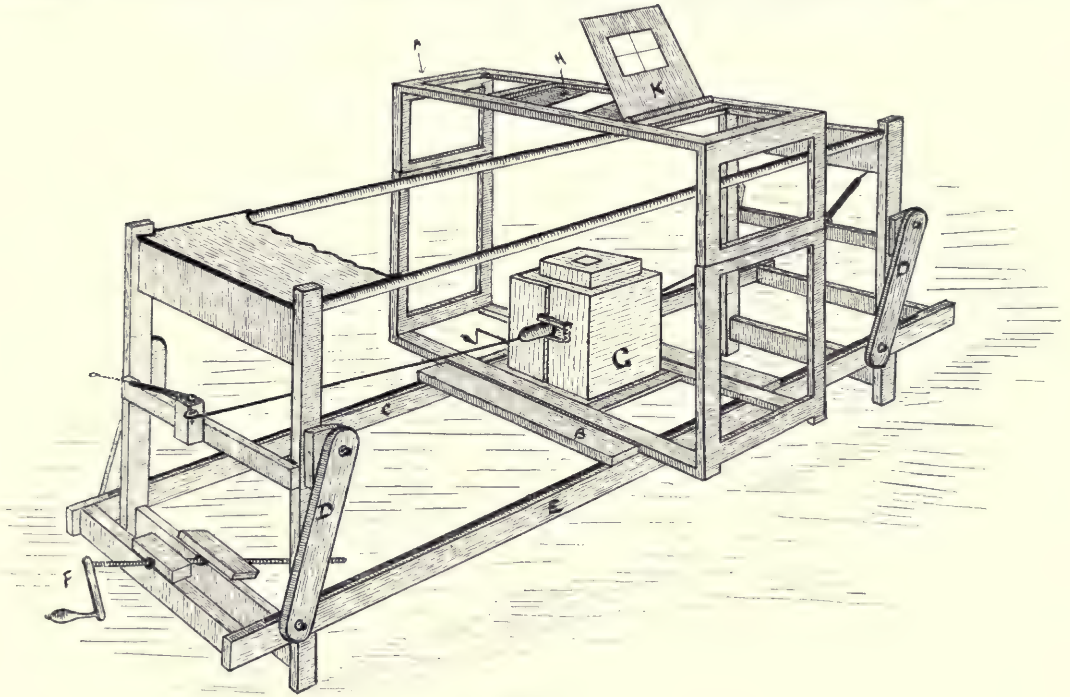


Fig. 1.

view to improving on the methods originally used there, viz., the procedure which may be termed the "triangulation method," either applied directly on the screen, or by the double exposure on a single plate. The former was found—even when the greatest care was taken—to be decidedly inaccurate. The double exposure on a single plate produces a negative which is deficient in detail, is confusing to the surgeon, and not infrequently, when the patient is stout and the foreign body a considerable distance from the plate, so much fogging that it is impossible to detect the two images of the projectile.

These disadvantages are overcome in the new apparatus, in which, in addition to the tube, the plate is also given a fixed displacement. We then obtain on the two halves of the plate two plain skiagrams standing in a fixed relation to each other. From the plate the depth of the foreign body may be read off directly on a suitable scale, and the fact that both skiagrams are on one plate is very convenient for stereoscopic examination. The apparatus has the further advantage of greatly increasing the simplicity, accuracy and safety of screen examinations and the marking of the patient.

The majority of the localizations by this method may be accomplished with the tube below the couch (Fig. 1), but for high-class negatives for slanting regions of the body, especially of the shoulders, it is advisable to adopt the tube over couch system (Fig. 2).

Both sets of apparatus are used on the same couch. The distance of the tube from the plate is fixed at 50 cm., and the movement of the tube chosen is 6 cm. It has been arranged that the tube in travelling the 6 cm. moves along the arc of a circle having a radius of 50 cm. This enables a diaphragm to be used which gives the exact size of the plate. Two sizes of plates are used—a large one 8½″ by 13″. This enables one to obtain two 8½″ by 6½″ skiagrams on the same plate. A smaller size—10″ by 4″ is used for economical reasons when possible. Both are viewed by means of a simple prism stereoscope. The depth of the foreign body from the skin is read directly off on a scale engraved on glass.

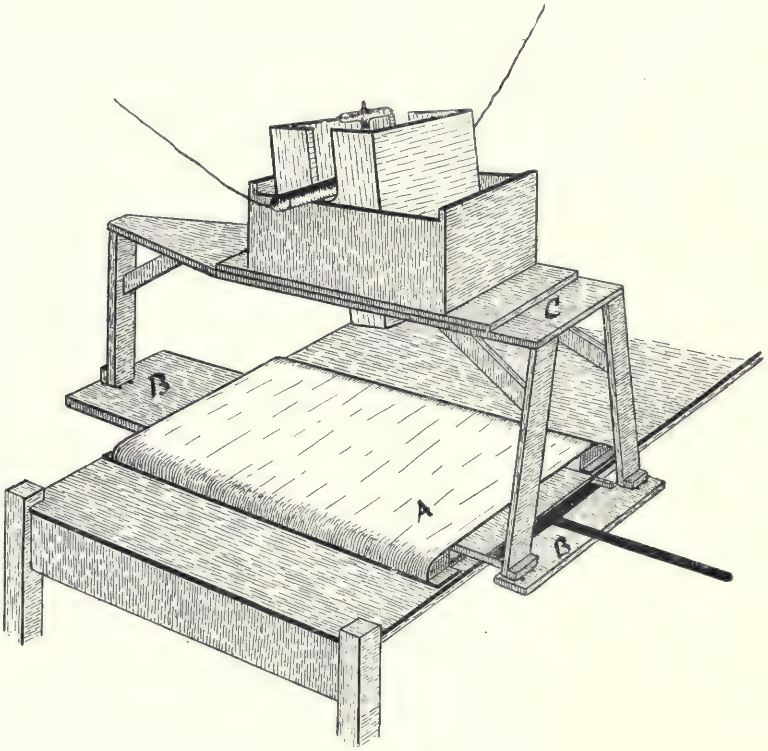


FIG. 2.

The apparatus (Fig. 1) which is used when it is desired to work the tube below the couch, consists of a rigid rectangular frame (A), which carries the tube box and screen (or plate) at a fixed vertical distance apart. The frame encircles the table top, and moves transversely and longitudinally. The upper section may be removed to allow the patient to be laid on the table. The whole frame runs by means of ball-bearings on a narrow platform (B), which again is carried, and moves on two rails (C and E) running the length of the table. These supporting rails are attached to the table by means of short parallel bars (D). Hence the rails themselves are parallel, and by means of a screw adjustment (F) may be raised or lowered at will.

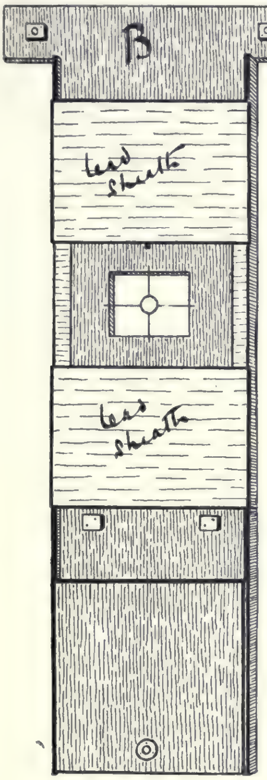


FIG. 3.

It is, therefore, possible to raise the tube, or to slide it along the length or breadth of the table. The frame itself may be said to consist of an upper and lower platform joined together by lateral supports.

In the centre of the lower platform is the tube box (G). This has an independent lateral movement 3 cm. each side of the centre line. As already mentioned, this movement is along the arc of a circle, the centre of which is formed by the crossed wires. In the centre of the upper platform of the frame is a sheet of lead, which has an opening measuring 8½″ by 6½″. On a light hinged structure (K)—(in the diagram it is raised to show the opening in the lead)—fitting over this opening are two wires crossing in the centre of the aperture. The cross is 50 cm. above the anode of the tube. The tube is centred by dropping a plumb line from the cross, so as to make the anode vertically under the cross.

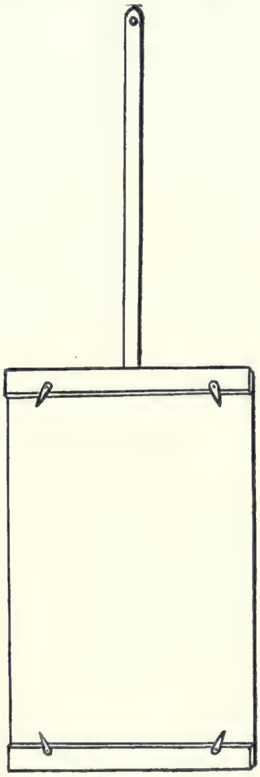
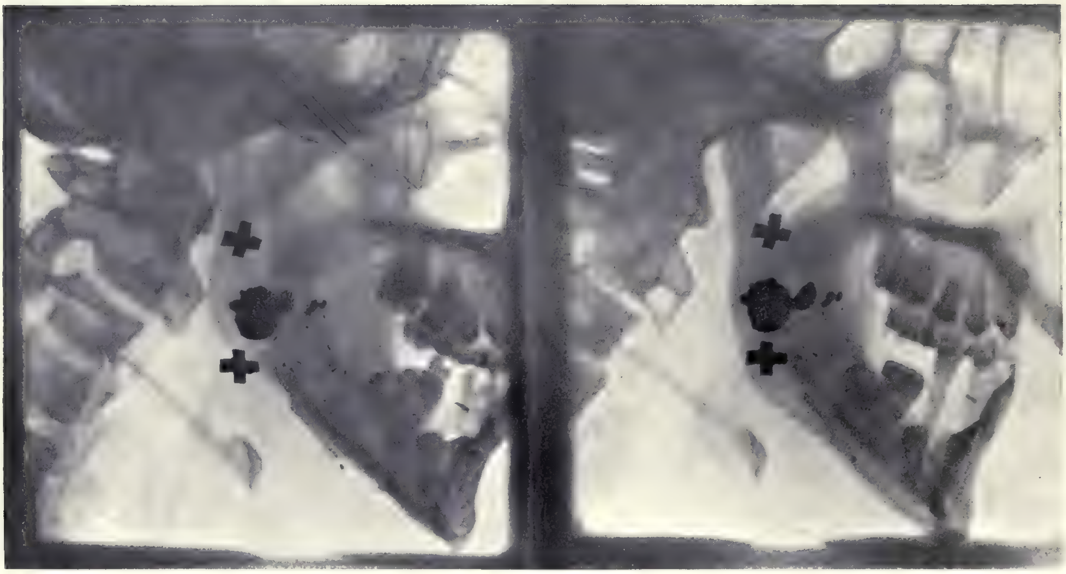


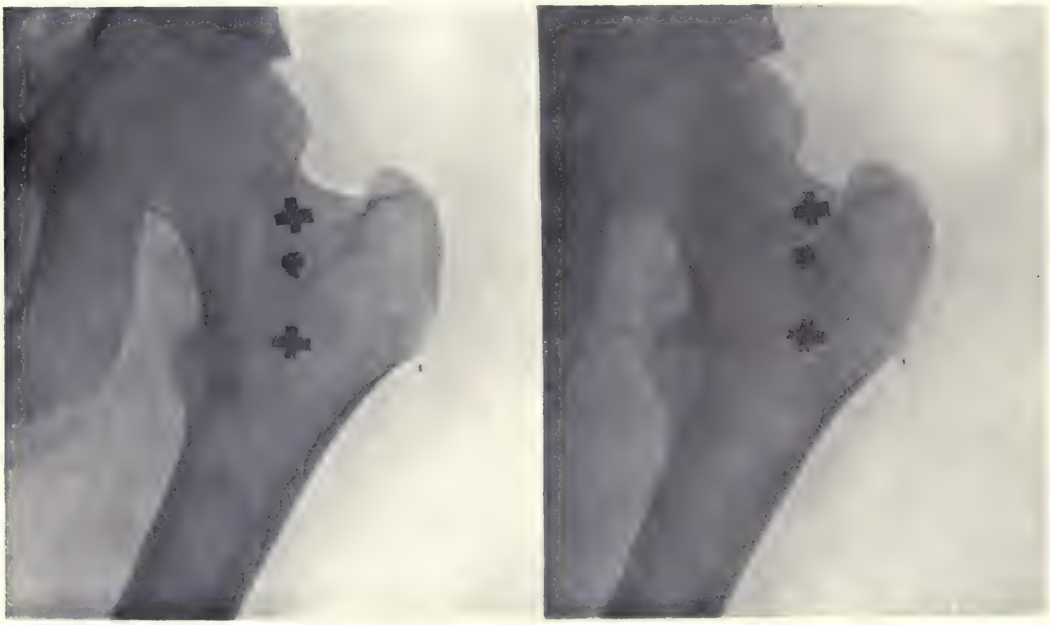
FIG. 4.

The procedure adopted where a case is to be localized is as follows: The upper part of the rectangular frame is lifted off to enable the patient, either with or without a stretcher, to be placed on the table. The height of the whole framework is then arranged relatively to the thickness of the patient. The fluorescent screen is placed over the 8½″ by 6½″ opening. The patient can now be rapidly screened by moving the whole framework, and since no rays pass except through the opening which moves with the tube, the screening is comparatively safe. If there is a foreign body the frame is moved until the centre of the crossed wires coincides with it. This process is extremely easy, and when finished means



REPORT TO SURGEON.

Shrapnel bullet, 3·6 cm. deep, vertically under mark on face when patient is lying on his left side. Stereoscopically it is seen to be free from bone, on the inner side of the angle of the jaw. The smaller fragment is 1·6 cm. deep, and is on the external surface of the bone.



A small piece of metal lying 1 cm. vertically under a mark on the anterior surface. Necrosis of the great trochanter, due to a piece of shell already removed.

Plate 31.

that the focus point, the foreign body, and the crossed wires have been arranged to be in the same vertical line by a single adjustment. A plumb line is now dropped from the centre of the crossed wires to the skin. The skin is marked, and a piece of strapping containing two lead crosses, 3 cm. apart, is placed on the skin. By means of the screw adjustment already mentioned, the whole frame is lowered until it touches the skin. The frame carrying the cross wires is raised and half the plate is placed over the 8½″ by 6½″ opening (the other half lies on the lead), the tube box is given the lateral movement of 3 cm. and the first exposure is then made.

In the second exposure, the tube box is again moved and the second half of the plate pushed into position. The plate is carried in a frame which moves against stops, so that it undergoes a displacement of 6½″. From the negative thus obtained, we are able to have a stereoscopic view of the foreign body and its anatomical relationship, also the depth of the bullet from the crosses is directly ascertained from a scale engraved on glass.

Should it be desirable to take a negative with the plate under the patient, then an aluminium casette or tunnel (Fig. 2, A), which is the width of the table, is placed under him. A tray (Fig. 3 and Fig. 2 (B), which is longer than the tunnel, slides into it. A three-legged tube box stand (C) is then placed over the patient, the legs fitting on to grooves in the tray. The tray and tube stand are then moved together until a plumb line, falling from the centre of the tube box, is over the mark on the skin already fixed as previously described. The tube box is then moved the stereoscopic distance, and a plate on its carrier (Fig. 4) slides into position on the tray (the half which is to be used for the second exposure fitting into a lead-covered sheath). The position of the tube box and plate are changed in a few seconds for the second exposure.

As the anode to plate distance and tube movement are always the same when using either set of apparatus, a simple scale suffices for the estimation of the depth of the foreign body.

I am indebted to Dr. S. R. Milner, the assistant radiographer, for designing the details of the apparatus, and for the construction of the measuring scale.

REVIEW.

Fibrositis: so-called Chronic Rheumatism, including Villous Synovitis of Knee and Hip, and Sacro-Iliac Relaxation. By Ll. Jones Llewellyn, M.B. London, Senior Hon. Physician, Royal Mineral Water Hospital, Bath, and A. Bassett Jones, M.B. London, late Senior Hon. Surgeon, Cardiganshire General Hospital. Pp. 693. London: Wm. Heinemann. 1915. 25s. net.

Under the above title the authors deal with the subject of Chronic Rheumatism or Fibrositis.

Three main divisions constitute the skeleton framework of the book, viz.:—

(1) Infective or toxic fibrositis.
(2) Traumatic fibrositis.
(3) Villous synovitis.

These groups are again sub-divided.

This most interesting subject is exhaustively dealt with in all its aspects. Diagnosis and treatment are all fully described.

The whole range of therapeutics is fully considered, and includes, among others, Radium, Electricity, and Radiant Heat.

The authors advocate the use of X rays in the examination of the intestinal canal in obstinate cases of Chronic Fibrositis. Of great interest to the radiologist are the photographs of joint conditions, taken from museum specimens, for they show many conditions with which the radiographer has to deal. The introduction of short anatomical descriptions, with plates illustrating these points, is bound to be of the greatest possible use to readers.

The various forms of joint change seen in Fibrositis are well illustrated by typical skiagrams; this is particularly so in the affections of the spine.

The many interesting points in diagnosis are fully entered into. The radiologist will find in this book much that will be of value to him in his consideration of doubtful points in interpretation and diagnosis. The clinical photographs are extremely good, and the colour plates excellent.

In the consideration of the diagnosis of rheumatoid or atrophic arthritis, attention is called to the atrophy of the cartilage of the metacarpal phalangeal joints, with destruction of bony tissue in the heads of the metacarpal and other bones Fig. 24 illustrates a hand showing chronic osteo-arthritic changes, where the heads of the terminal phalanges show cauliflower appearances, with rarefaction at the bases of the phalanges and occasional formation of osteophytes.

A valuable point in the diagnosis of infective arthritis is pointed out, namely, transparency of ends of bones, and no bony enlargement.

The authors devote some eight or nine pages to the place which radium-therapy has in fibrositis.

They remark upon the proved radio-active properties of the waters of Bath, and, *a propos* of the often discussed power of radium emanation keeping uric acid compounds in their more easily soluble forms, they quote the findings of *The Lancet's* special commission for the investigation of the said waters, which are as follows:—"The thermal waters of Bath exert a distinct solvent action on uric acid; in one experiment, for example, it was shown that Bath waters dissolved over five times the amount of uric acid that distilled water would similarly take up at blood-heat —*i.e.* just under 100° F. Since the waters are drunk hot, and used hot for bathing purposes, this fact may have an important relation to the therapeutics of Bath waters in the treatment of chronic gouty affections and rheumatism."

In the authors' opinion there is no doubt that cases of gout and chronic rheumatism are often much benefited by radium emanation treatment; they question what is the best dose in this connection. Is the water as provided in the natural spring waters of high enough emanation content, or would better results be obtained by using artificially prepared emanation waters of greater strength?

It seems to us that the authors deal with the question in a well-balanced manner, and they finally remark:—

"Out of the somewhat extravagant claims put forward, however, one salient fact emerges, that artificial, like natural radio-active waters, have their limitations. While under their influence, subjective amelioration ensues, and even tophi may disappear, yet both alike are powerless, apparently, in the presence of structural changes."

NOTES AND ABSTRACTS.

Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Co. (1913-1914).

The Physical Chemistry of Photographic Development. By C. E. Kenneth Mees.—Photographic development is the reaction which has made modern photography possible; namely, the selective action of some reducing agents upon silver halide which has been exposed to light so that it is rapidly reduced to metallic silver, while unexposed silver bromide is either not reduced at all, or with much greater difficulty.

There are three factors in development: (1) the construction of the emulsion, (2) the effect of light upon that emulsion, (3) the chemical nature of the reducing agent employed.

(1) The Emulsion. A photographic emulsion consists of gelatine containing suspended in it small crystalline grains of silver halide from 1 to 2 μ in diameter, these grains containing a small quantity of silver iodide, possibly in the form of complex bromo-iodides. Gelatine has a spongy structure, and diffusion into it may be divided into two processes; (*a*) macro diffusion or the penetration of the

solution through the channels of the gelatine, and (*b*) micro diffusion or the penetration through the cell walls.

(2) Exposed Silver Bromide. The change which silver bromide suffers on exposure to light can be investigated by considering the energy involved, and a calculation due to Dr. Nutting shows that each grain of silver bromide, which contains on the average 10^{12} molecules, receives 10^{-14} ergs to make it developable. This is of the same order as the amount required to detach an electron from a molecule, so that the latent image may be imagined to consist of grains in each of which one molecule has lost an electron by the action of light.

(3) Reducing Agent. If we consider the equilibrium at a single grain of silver bromide in an emulsion which is being attacked by a solution of a reducing agent, then we may consider the latter as a dibasic ion R^{--} tending to oxidize to R. The silver bromide goes into solution to the extent represented by its solubility product, giving silver ions, which lose their charge and produce silver molecules in solution.

This will then produce equilibrium unless the silver can precipitate, in which case more silver bromide will dissolve, which will precipitate as metallic silver in turn and the reaction will proceed until the whole grain is dissolved.

The Physics of the Photographic Process. By C. E. Kenneth Mees.—The unit of the photographic emulsion is the grain, and in order to study its properties we must study the properties of the individual grains. The grains are held in a sponge of gelatine, which is believed by Quincke to have a two-phase structure, one phase constituting the cell walls, and the other a solution filling the channels and cells themselves. Through these channels in the gelatine the migration of ions can take place at a velocity comparable with their diffusion rate in water, while penetration through the cell walls is a much slower and more difficult process.

Development consists of a reaction between an ion of the reducer and an ion of silver from the dissolved silver bromide, the silver ion being reduced to metallic silver in solution, which must then either precipitate or bring the reaction to an end. Precipitation can be induced only by the presence of a nucleus, and consequently in the absence of a nucleus for any grain, that grain will be undevelopable, the provision of the nucleus being the function of the "latent image." From a consideration of the energy required to produce a latent image in a high speed photographic material, it can be shown that the energy available per grain is of the same order as that required to ionize one molecule of a gas, and it is, possible, therefore, that the latent image is composed of grains of silver bromide in each of which, on the average, one molecule has lost an electron by the action of light. The action of light on a photographic emulsion may, therefore, be classed as a photo-electric effect, and, as is the case with other photo-electric effects, the light must have a frequency above a certain critical value, the critical value depending upon the salt of silver employed, being about $400^{\mu\mu}$ for silver chloride, and $480^{\mu\mu}$ for silver bromide.

It seems probable that reversal is due to a slow decomposition of the silver bromide and liberation of bromine, which then attacks grains which had been exposed and contained a nucleus, rendering them undevelopable, or, at any rate, less easily developable.

The size of the grain has several influences on the properties of photographic materials In high speed emulsions, if we assume that all the grains are equally sensitive, then the mass of silver produced for a given exposure will vary as the cube of the diameter of the grain, and the range of the sensitiveness experimentally found in high speed emulsions can be accounted for by variation in the size of the grain without making any other assumptions.

It seems to be a fact that there is a qualitative difference between high speed and low speed emulsions which must be due to the nature of the grains. If we start with a very fine grained emulsion and cook it, the size of the grain and the sensitiveness will only increase to a certain limited extent, and in order to get a high speed emulsion having larger grains and much greater sensitiveness, we must start in an entirely different manner, precipitating the silver of medium grain, which can then be increased in size with a concomitant increase of sensitiveness. The difference may be that in the low speed type the silver grains consist of a network of crystals containing gelatine, while in the high speed emulsions the gelatine is distinctly separated from the crystals, so that in a low speed emulsion each of the crystals forming part of the grain must be made developable by the action of light, while the large grain of the high speed emulsion requires action only at one point to make it entirely developable, the energy required to form a latent image in a high speed emulsion being only that necessary for the liberation of one electron per grain, while in the low speed emulsion several electrons for each grain may be necessary. Inasmuch as the grains of high speed emulsions are not homogeneous in size, the sensitiveness will depend on the distribution of the grains of different size, and so also will the shape of the plate curve.

With a homogeneous emulsion we should have a simple curve with short over- and under-exposure portion, but if the size of the grains varies more about the mean, then a curve having a longer straight line can be obtained, while any special distribution of the grains will be accompanied by a corresponding change in the shape of the plate curve.

The resolving power of an emulsion represents its abiity to give sharp images and depends upon the side spreading of the light in the emulsion itself. It can be examined by printing images of the edge of a steel blade on the emulsion by parallel light, the distribution of the image inside the shadow of the blade being afterwards investigated. It has been shown that there are three factors in the resolving power: (1) the scattering power of the emulsion for light, (2) the absorption of scattered light by the emulsion, and (3) the photographic factor, which covers the reproduction of the light distribution as density distribution in the developed plate.

The distance between the two lines which will just be separated with a given emulsion will be extremely small for extremely small sizes of grain, because such sizes of grain far below the wave length of light will scatter very little light; that is, the turbidity will be negligible. As the size of grain rises, however, the turbidity increases very rapidly, and with it the distance necessary to separate two lines, until with a grain diameter a little less than 1$^{\mu}$ the turbidity is high and the opacity still low, so that the necessary separation of the lines is a maximum, and then, as the grain still grows, the opacity grows faster than the turbidity and the lines to be separated can be somewhat closer together. Then again, with the increasing diameter of the grains the actual space factor comes in, the size of the grains themselves and the distance between them becoming comparable with the distance between the separated lines, and with increasing size of grain this distance must again increase steadily.

NOTICES.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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RADIOGRAPHY OF NORMAL PARTS.

By Archibald McKendrick, F.R.C.S. (Edin.).

(*This work was carried out under the auspices of the Carnegie Research Fund.*)

It is well known that an ordinary photograph of any familiar object may be exceedingly difficult to interpret, if an unusual point of view has been chosen by the photographer.

Some time ago a series of such photographs was printed by the publishers of a well known magazine, and valuable prizes offered by them to anyone who interpreted the greatest number correctly. In this case the point of view, or, as we might call it, the focus-point, was the only factor causing difficulty in the correct interpretation.

In radiography we have to deal, not only with suitable focus-points, but with the position of the limb or joint, as the case may be, at the time of making the exposure.

A badly chosen focus-point, in conjunction with an unsuitable position of the limb, may result in a radiograph analogous to the puzzle pictures mentioned above. This gives rise to what is called " distortion " in the radiograph. The term distortion is an unfortunate one, because, so far as casting shadows is concerned, X rays behave in exactly the same way as ordinary rays of light. The shape and size of the shadow cast by any intervening object can be calculated mathematically ; the shadow, although it may appear unrecognisable, is not actually distorted, but only apparently so. See Fig. 1a of a normal foot taken from an unsuitable focus-point. Anyone might be excused for expressing the opinion that the ankle had sustained a severe dislocation, or that the case was one of a badly united Pott's fracture. This picture shows how far a surgeon might be misled by a radiograph, through his not knowing the conditions under which the exposure was made. Imagine the case of a malingerer who alleged injury to his foot. Several surgeons might examine the foot, and be able to swear in Court that the foot was absolutely normal. An X-ray picture similar to Fig. 1a might be taken of his normal foot, and the discomfiture of the various surgeons who pronounced the foot normal can easily be imagined, if such a radiograph were put into their hands in the witness-box after their evidence had been given.

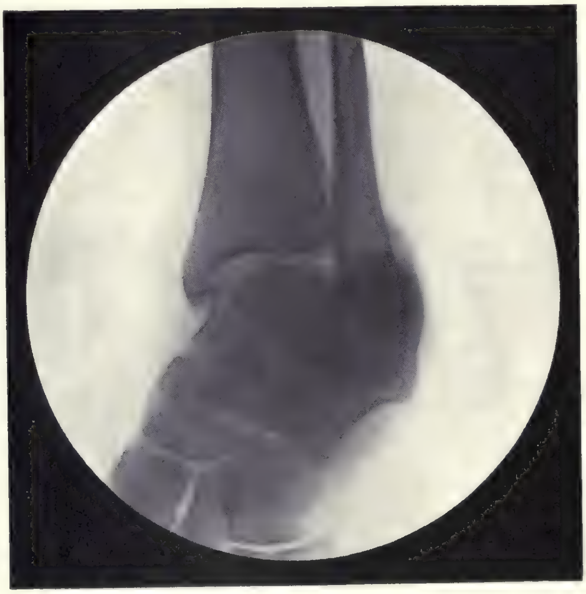

FIG. 1a.

The absence of any standard for comparison is sufficient justification for the present chapter.

Fig, 1 is a puzzle radiograph, similar to the above mentioned magazine puzzle pictures. In it, eight familar objects have been placed upon an X-ray plate, and an exposure made with the tube 24 inches directly over the centre of the plate.

An expert radiographer will have difficulty in recognising even one of these objects. In Fig. 2 all the original relations have been retained, but the tube has been displaced four inches to one side. Anyone accustomed to the examination of radiographs will now be able to recognise at least two of the objects, viz., the button, and the safety-pin. The reason for this is not far to seek. These objects are frequently seen from various points of view in radiographs, but it is unfair to say that the shadows are distorted.

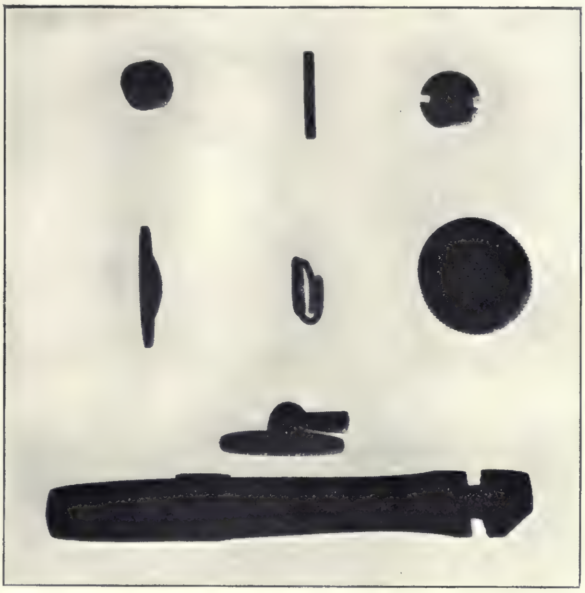

FIG. 1.

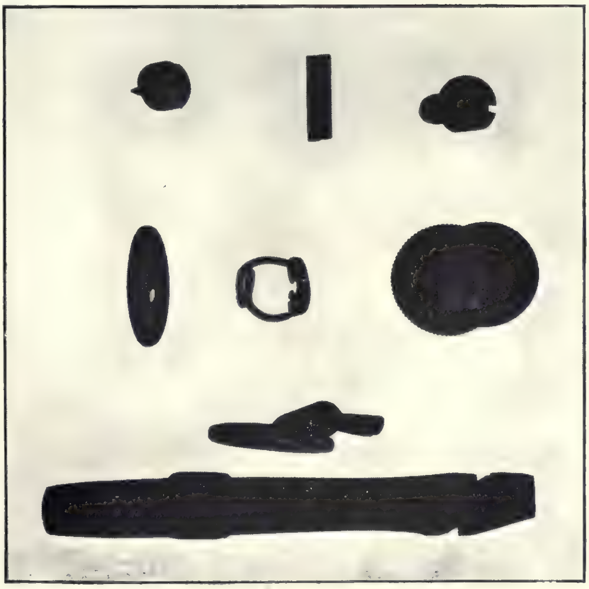

FIG. 2.

In Fig. 3 the same objects have been placed in such positions that each of them can be easily recognised. If now the tube be moved four inches to one side, the objects cast almost exactly similar shadows (as in Fig. 4) to those cast in Fig. 3.

We learn from this, that radiographs of any object which is lying with its long axis in a plane parallel to that of the plate will be apparently little altered in shape if a different focus-point is chosen. If, on the other hand, an object such as the neck of the femur, which is not usually lying in a plane parallel to that of the plate, is being radiographed, an alteration in the focus-point will make a marked difference in the shadow cast. The radiographer should be able to place the limb in the best position for attaining the best relationship of the part to be examined to the plane of the plate.

The following experiment will show how actual distortion does not occur, and how apparent distortion may be calculated mathematically. Take a darning needle, and mark its centre with a piece of wire. Stick the point of the needle into a foot-rule, and allow the shadow from a point of light to fall along the rule. It does not matter whether the needle is vertical or is lying at an angle to the rule. If the source of light is at infinity, it does not matter how it is moved, the relationship of the shadow of the two halves of the needle is constant. That is to say, the ratio of the distance of the wire from either end will be constant. If the source of light is vertically above the wire, and is gradually lowered, the length of the shadow of the pointed end of the needle does not change, but the length of the distal end gradually increases.

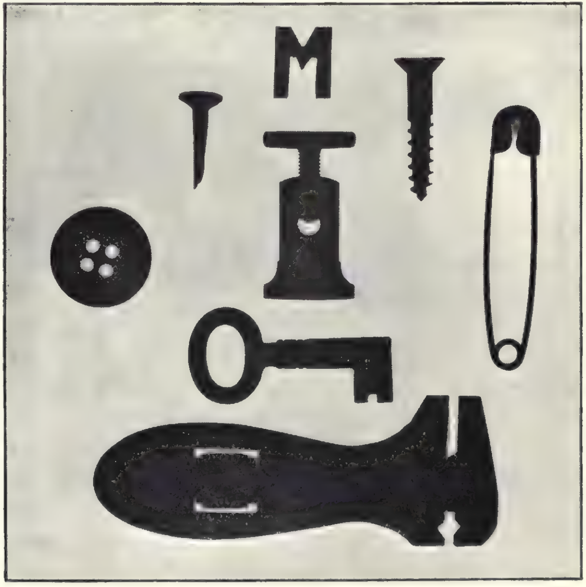

Fig. 3.

If the needle is now suspended by its centre, and is made to lie in a plane parallel to that of the rule, it does not matter how the position of the light is changed, upwards, downwards, or sideways, the shadow of the wire will always be in the centre of the shadow of the needle. If the needle is several inches distant from the rule, movement of the light towards it will increase the length of the shadow. If the needle is only one inch from the plate such elongation of the shadow will not be apparent. We learn from this, that (1) the more nearly parallel the long axis of the object to the plate, the less the apparent distortion.

(2) The nearer the object is to the plate, the sharper the outline, the more accurate the shadow, and the less influence the position of the focus-point. (3) The further the focus-point from the object, the more nearly does the shadow correspond in size to it. A radiographic rule might be laid down that, the nearer the object to the plate, and the more nearly parallel it is to the plate, the less care need be bestowed on the choice of focus-point.

It should be the endeavour, therefore, of the radiographer to place the object as nearly parallel to the plate and as close to it as possible. In the hand, for example, fracture of the scaphoid is a very common injury. Its detection is often exceedingly difficult in a radiograph taken with the hand in its ordinary position. This is because the fracture occurs across the long axis of the bone, and the long axis of this bone does not lie in a plane parallel to that of the plate. If the hand be placed with the palm flat on the plate, and put into a position of extreme ulnar deviation with the thumb abducted, the long axis of the bone is brought nearly parallel to the plate. A radiograph taken now will show the scaphoid in its full length, and a fracture, which is not easily recognisable in the ordinary radiograph, is now quite apparent.

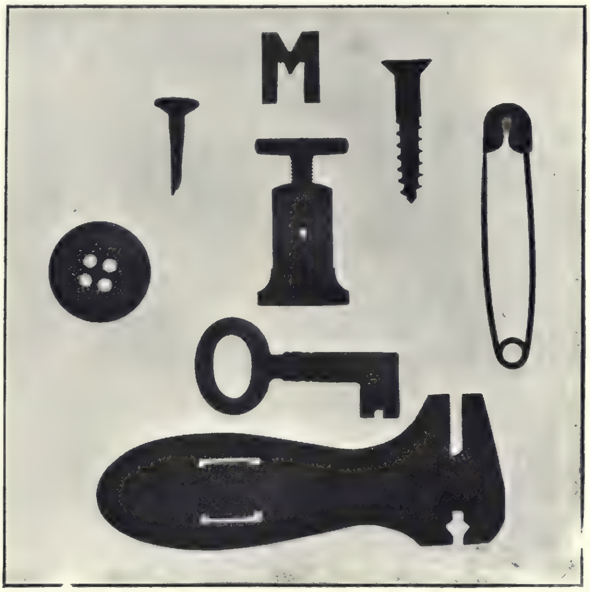

FIG. 4.

There is no doubt as to the advantage which would accrue if a series of "normal focus-points" and "normal positions" could be agreed upon by all radiographers. By such means we would be able to compare, not only subsequent radiographs of the same joint but all "normal" radiographs of any joint.

It would be a convenient nomenclature if we reserved the term "normal focus-point" for that point 24 inches (60 centimetres) directly over the centre of the joint, with the centre of the joint in the middle of the plate. This is a suitable distance for several reasons. It is approximately the distance from which the plate is examined. It is suitable for stereoscopic work. It is suitable for the various forms of compression apparatus.

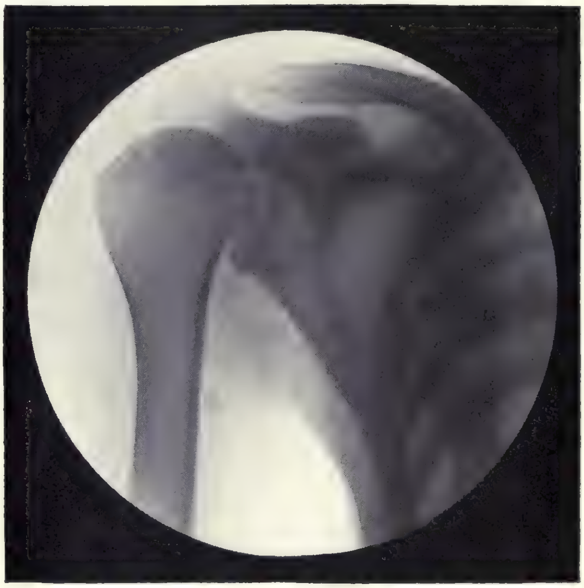

Fig. 5.

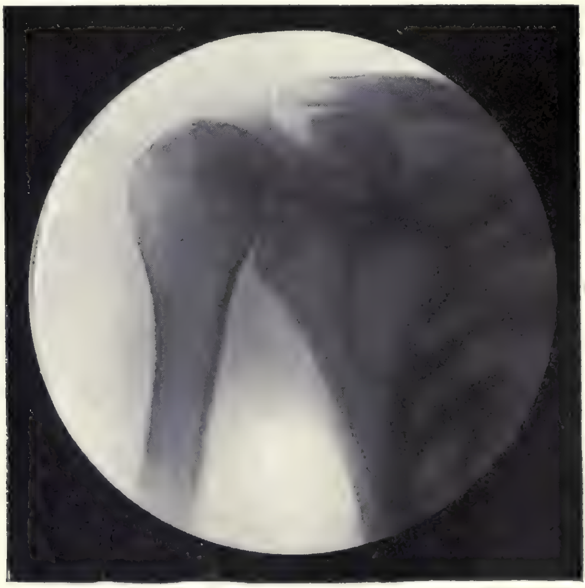

Fig. 6.

It is a convenient distance from the point of view of stability of apparatus. It is sufficiently far from the object to prevent so-called distortion, and sufficiently near to enable us to make the exposures reasonably short.

The choice of "normal positions" will be discussed with the individual joints.

SHOULDER JOINT. *Normal position.*—With arm by the side.

This position is chosen because it is the most natural position of the limb. It is the position in which it is usually bandaged in injuries about the joint. In all cases of stiffness of the joint this is the natural position.

Anatomically, it should be noted that the range of movement in the shoulder joint itself is much less than anatomical text books make out. Rotation of the head of the humerus is limited to little over the quarter of a circle. The int. condyle of the humerus indicates the direction in which the articular portion of the head of the bone is pointing. Its range of rotation is from directly inwards to a little more than directly backwards. The natural position of the limb is with the head and internal condyle midway between these two extremes. If the arm is lying across the chest the head is directed a little more backwards, and the angle through which it has been rotated is so small that it may be disregarded.

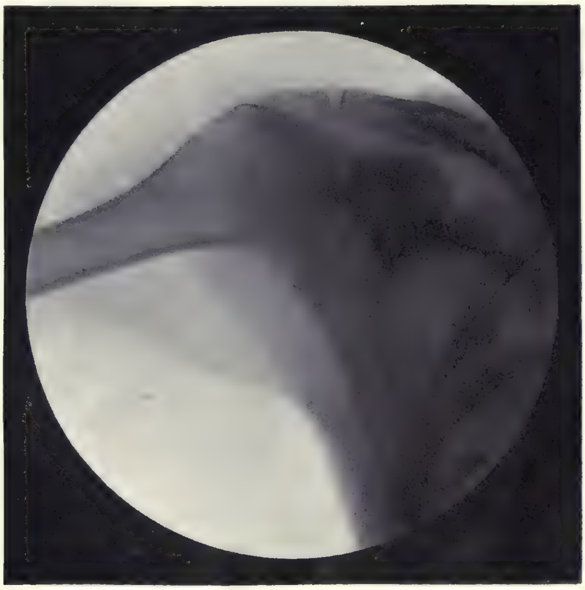

FIG. 7.

The long axis of the humerus should be kept parallel to the plate, so that the only other movement which we have to consider is that of abduction.

In the natural position of the limb the inner portion of the anatomical neck lies about the junction of the lower and middle thirds of the glenoid cavity (Fig. 5). In abduction to nearly a right angle, the anatomical neck reaches the lower edge of the glenoid (Fig. 7). If further abduction is attempted these relations are practically undisturbed, and the movement is effected by movement of the scapula. Abduction then, like rotation, is only through about the quarter of a circle.

From this it will be seen that the position of the limb makes very little difference in the picture produced. The choice of focus-point, however, makes a considerable difference.

It should be noted that the glenoid cavity is directed outwards and forwards, and that it, the clavicle, the coracoid, and acromion processes are lying in different planes. This is the reason of the altered picture with alteration of the focus-point.

Fig. 5 is taken from the normal focus-point. In it a good general view of the joint is obtained.

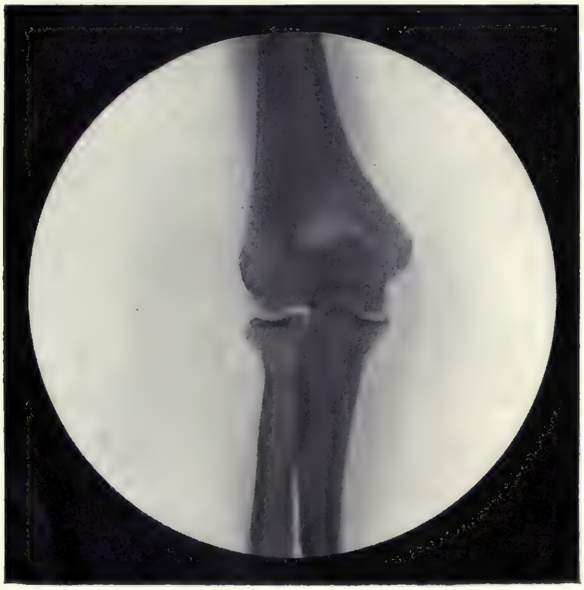

FIG. 8.

If the tube is focussed four inches internal to this, the glenoid cavity is seen more in profile, and the coracoid process appears longer.

With the tube four inches external, the face of the glenoid is better seen, and the coracoid which is directed outwards will be seen more "end on."

With the tube focussed for four inches above the joint, the acromion, which in all other positions overlaps the glenoid and head of humerus, is apparently thrown upwards out of the way, so that with this view practically the whole of the head of the humerus and the whole of the glenoid cavity are seen at their best. The tip of the acromion, however, is seen "end on," and the shape of the coracoid cannot be well defined.

Fig. 6 is taken with the focus-point four inches below the joint. The coracoid shadow is thrown clear of the acromion and clavicle, and the tip of the acromion is best seen. This is the best position for the unusual conditions: fracture of the tip of the acromion, and persistent acromial epiphysis.

Fig. 7 shows the arm in abduction, focus-point normal. No advantage is gained from this position.

ELBOW JOINT. *Normal positions.*—This joint may be taken antero-posteriorly and laterally.

Antero-posterior—Arm straight, with bones parallel to the plane of the plate. In this position the bones are parallel to the plate and very near to it. The choice of focus-point will therefore make little difference to the picture produced.

Fig. 8 is from the normal focus-point. This gives the best view for all practical purposes.

With the tube four inches internal. This throws the shadows of the bones of the forearm further apart, and therefore gives a better view of the radius.

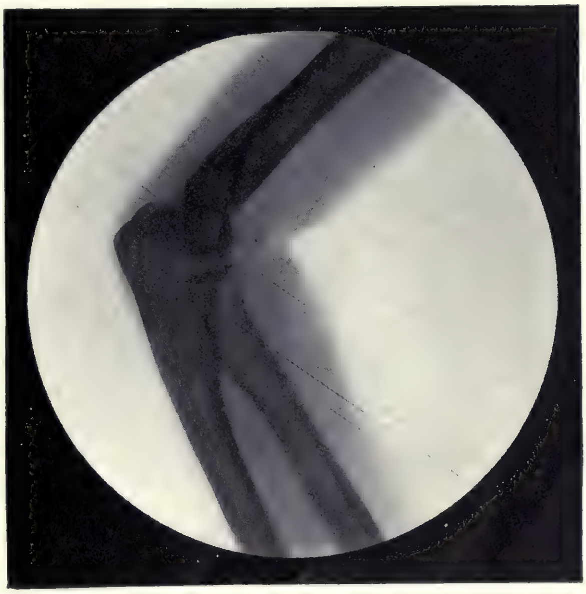

FIG. 9.

With the tube four inches external. This produces overlapping of the shadows of the radius and ulna.

With the tube respectively four inches above and four inches below. These are scarcely distinguishable from the radiograph taken from the normal focus-point.

Laterally.—It is convenient to call the semi-flexed position the normal, because in affections of the joint this is the position of greatest ease. It is also the position in which patients can keep the limb steady. Pronation and supination make very little difference in the picture produced.

The internal condyle is on the plate, and the bones are lying parallel with the plate, so that choice of focus-point makes very little difference.

Fig. 9 is from the normal focus-point, and is the best for all practical purposes. If the tube is placed four inches internal, four inches external, four inches above, and four inches below, it will be noticed that there is not much difference to be seen in any of the views. If anything, the views from above and below the level of the joint produce overlapping of shadows about the joint.

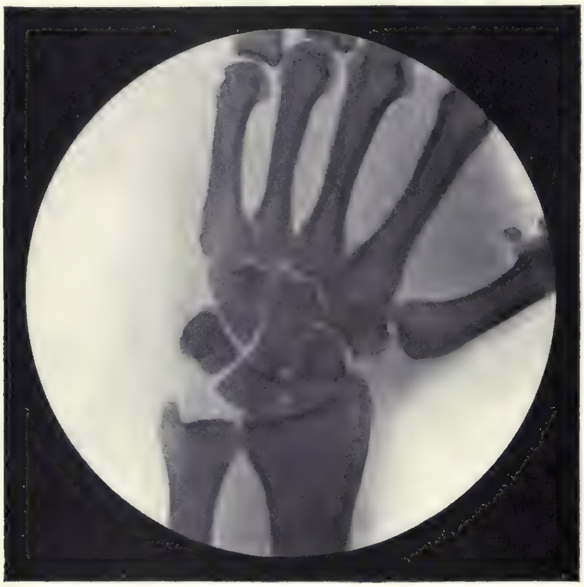

Fig. 10.

Wrist and Carpus.—The movements of the wrist joint are slightly complicated. Dorsiflexion and palmar flexion occur mostly at the radio-carpal joint. Ulnar and radial deviation of the hand produce not only movement at

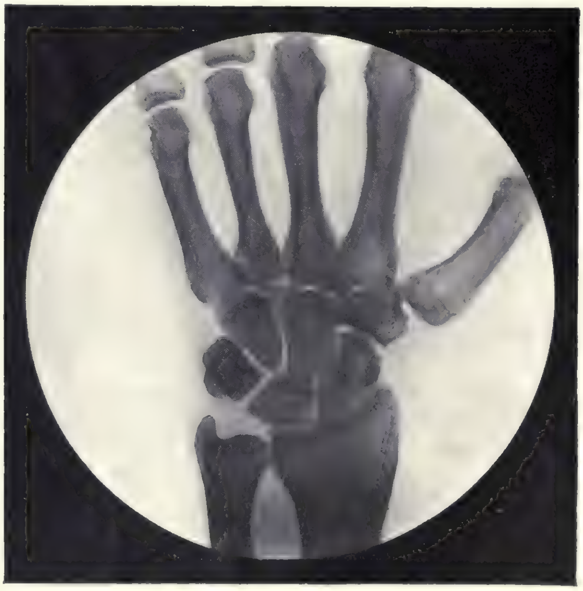

Fig. 11.

the radio-carpal joint, but during their performance each individual carpal bone undergoes a change in position.

Focus-points.—Radiographically, no advantage is gained by a different choice of focus-point, because the bones are all in near apposition to the plate. The normal focus-point may be chosen as between the styloids. Alteration in the position of the limb makes a marked difference.

Antero-posterior view.—This is taken with the palm on the plate. When the hand is held in the position of full radial deviation, as in Fig. 10, the scaphoid is seen almost "end on," with the articular facets for articulation with the trapezium and trapezoid near the tip of the radial styloid. The articulation between the scaphoid and os magnum is very badly seen. The semilunar is seen to be half off its articulation with the radius. The long axis of the os magnum, unciform, cuneform, and scaphoid are directed towards the inferior radio-ulnar articulation.

As the hand is moved into a position in a straight line with the forearm (Fig. 11) very little change is seen. The bones are still lying with their long axes towards the inferior radio-ulnar articulation. The semilunar is still half off its articulation with the radius, but the trapezium and trapezoid have moved further away from the radial styloid, and the scaphoid is seen more in its long axis. It is only when the hand is moved from the straight position towards that of ulnar deviation that a marked change is seen in the position of the individual bones of the carpus. (Fig. 12).

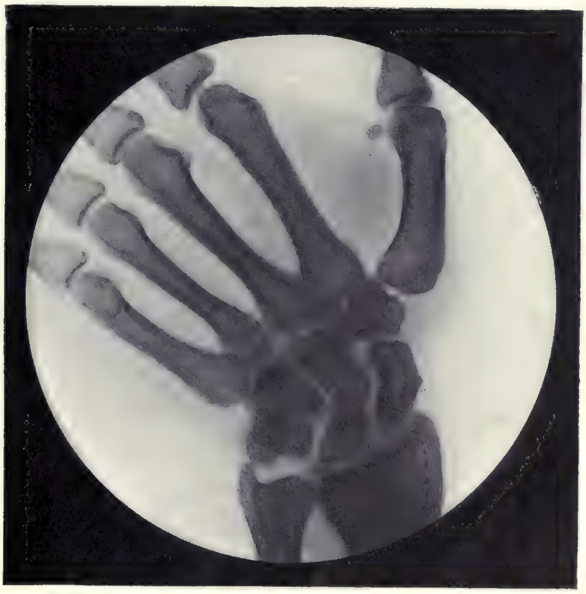

FIG. 12.

In full ulnar deviation, all the articulations between the individual carpal bones are well seen, excepting, of course, the trapezio-trapezoid articulation, which is not well seen in any position of the hand. It is only in this position that the scaphoid can be brought to lie with its long axis parallel to that of the plate. This position is, therefore, best for showing fractures of the scaphoid, as these fractures occur across the long axis of the bone. The majority of fractures of this bone, invisible in the ordinary position, are clearly seen when the hand is ulnar-flexed to its fullest extent. Throughout these movements the os magnum scarcely alters its relationship to the other carpal bones, but the unciform, cuneform, scaphoid, and os magnum in full ulnar flexion have their long axes directed more or less towards the radial styloid. In this position the semilunar is fully on its radial articulation, and the pisiform does not overlap the cuneform to such a marked degree as in other positions of the hand.

Lateral views of the wrist and carpus may be very misleading, because the shadows of the various carpal bones are superimposed upon one another. This superimposition is markedly influenced by either slight pronation or supination, and care must be taken that the articulation between the pisiform and cuneform is not diagnosed as a fracture of the scaphoid. (Fig. 13.)

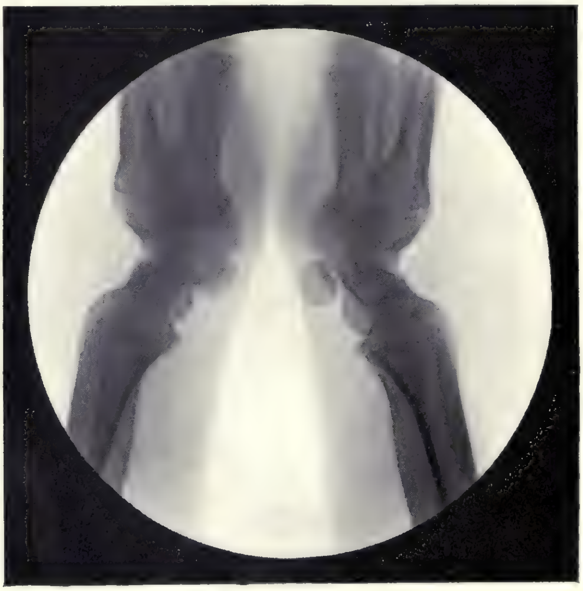

Fig. 13.

The best plan is to take both wrists on one plate, with the palms together, and the ulnar side of the hand in contact with the plate. This keeps both wrists steady in a difficult position, and affords an easy means of comparing the two sides.

Fig. 13 is taken with the palms in contact with one another. This is the best view for dislocation of the semilunar.

Fig. 14 is taken with the thumbs in contact with one another, and the ulnar sides of the hand separated from one another. This view shows the whole of the trapezium, and also gives a very good view of the scaphoid where a fracture of the condylar portion of this latter bone is suspected. This position is no use for showing a Bennett's fracture, and is misleading in cases of suspected dislocation of the semilunar.

Hip Joint. *Normal position.*—Buttocks on plate, legs together, and toes pointing directly upwards. There are several reasons for this choice of normal position. The buttock in contact with the plate is most suitable in the greatest number of cases, because when the hip joint is injured or diseased, the hip is usually flexed, and the patient cannot be easily turned on to his face. There is no doubt that the bones can be got nearer the plate when the plate in placed in front, but a couch on which radiographs can be taken from below is not always available.

The natural position of the limb is with the toes turned out. In this position the neck of the femur is not lying in a plane parallel to that of the plate, but is lying at a considerable angle to it. The head of the femur is directed inwards and markedly forwards. That is to say, the head of the bone is much further from the plate than is the great trochanter. A radiograph taken in this position will, therefore, show foreshortening of the neck. When the two hips are taken on the same plate, this same effect is produced, because the focus-point is between the two hip joints, and the X rays fall obliquely on to the necks. The "normal position" can always be reproduced, whereas the natural position can not, and the natural position in one patient is not the same as the natural position in another patient.

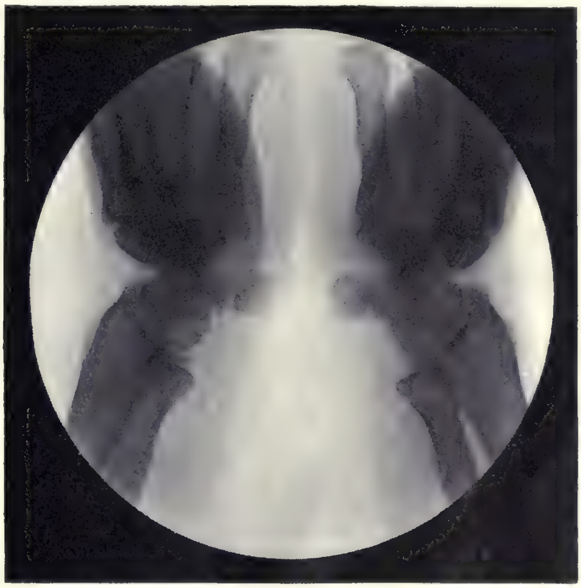

FIG. 14.

Another point of radiographic interest is the position of the lesser trochanter. This is situated towards the posterior aspect of the junction of neck and shaft. The extent to which it is visible affords a rough guide to the position of the limb at the time of the exposure. It should be noted that in normal hips the line of the under surface of the neck of the femur, and that of the upper border of the obturator foramen, form one continuous curve in every position of the limb.

Fig. 15 is taken in the "normal position," and from the normal focus-point, viz., directly over the centre of the joint.

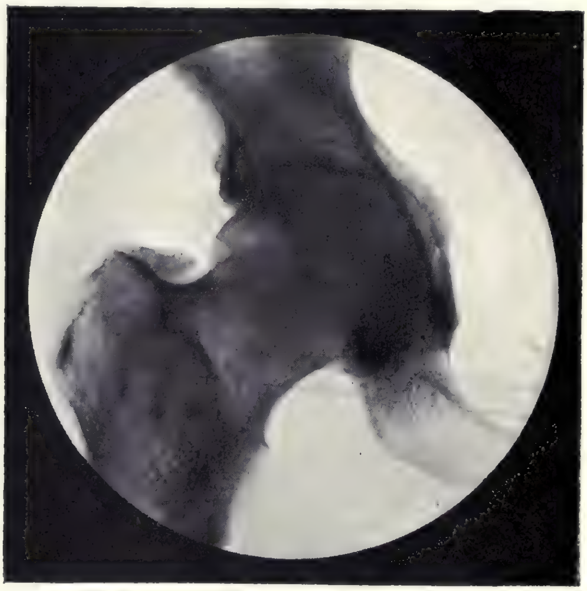

Fig. 15.

Fig. 16 is taken in the normal position, but with the focus-point four inches internal. This is the view we are familiar with where both hips have been taken on one plate. The neck of the femur will be noticed to be shorter. The upper edge of the acetabulum and the great trochanter are nearer to one

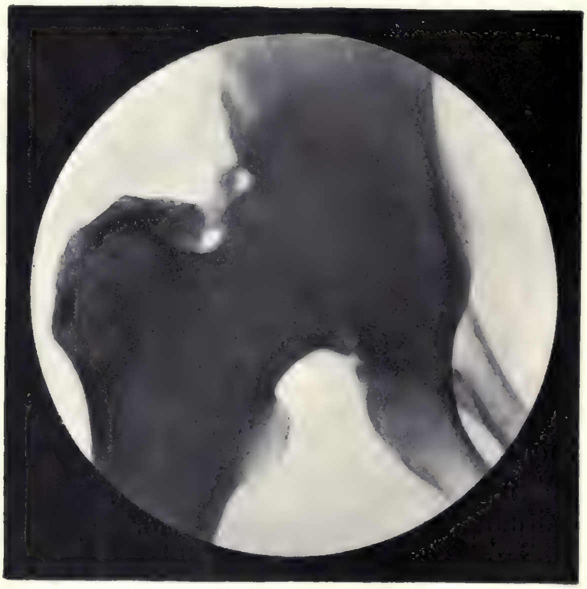

Fig. 16.

another. The lesser trochanter is not fully seen, and the obturator foramen is apparently narrowed down.

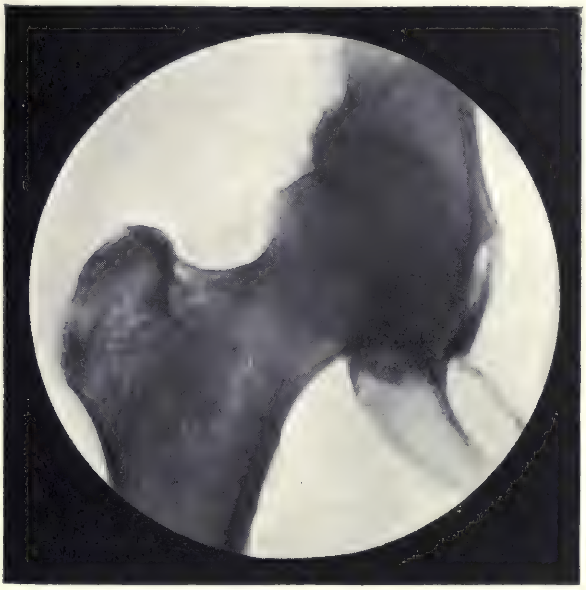

Fig. 17.

If the focus-point chosen is four inches external, the neck of the femur is shown in nearly its full extent, and the lesser trochanter will have nearly disappeared behind the shaft of the bone. This picture is very like that taken from the normal focus-point, but with the limb in a position of abduction and internal rotation.

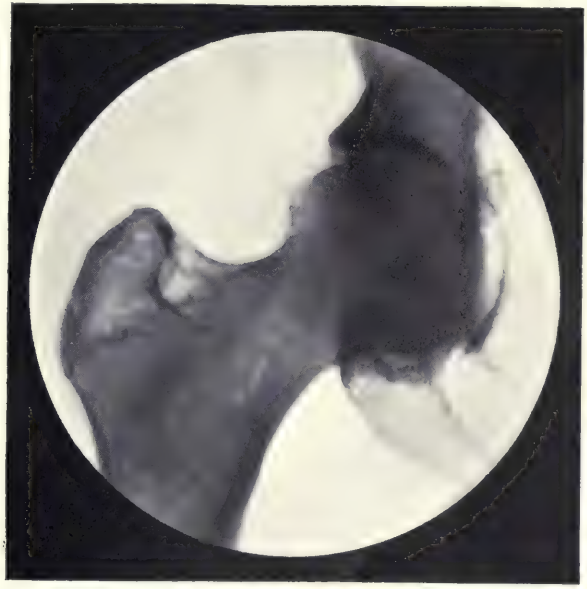

Fig. 18.

If the picture is taken respectively four inches above or four inches below the level of the joint, no advantage is gained, and apparently little is lost, for they are surprisingly like that taken from the normal focus-point.

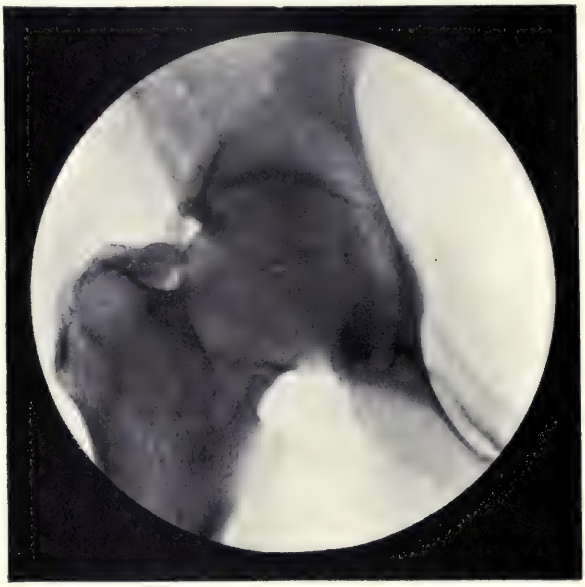

Fig. 19.

Figs. 17 and 18 are taken from the normal focus-point, but with the limb in the position of abduction and internal rotation, and internal rotation alone. The neck of the femur is here seen at its longest, the internal archi-

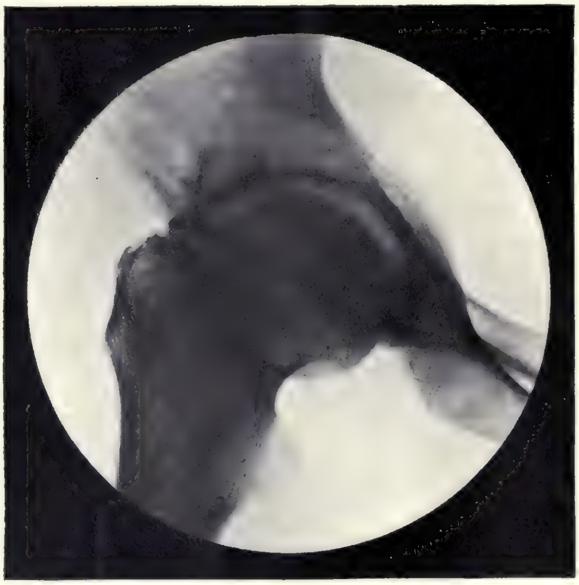

Fig. 20.

tecture of the neck is seen at its best, and the lesser trochanter has practically disappeared behind the shaft. It is well to become familiar with the X-ray appearance of the limb in this position, because it is the characteristic position of one of the stages of tuberculous disease of the hip.

Let the limb be taken from the normal focus-point, but with the limb in a position of external rotation alone, and external rotation plus abduction. It is well to become accustomed to the X-ray appearance of the limb in this position also, because it is characteristic of another stage of tuberculous disease of the hip. It is also the characteristic position in fracture of the neck of the femur. The neck of the femur is here seen at about its shortest, and the lesser trochanter at its fullest. This is not a position of choice, but one we should be familiar with for purposes of comparison. This gives the best view of the acetabulum and joint cavity.

(To be continued.)

ON THE MOVEMENTS OF THE COLON.

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I. *The bismuth meal.*—In the normal individual a shadow appears in the ileocolic region within four hours after the administration of an opaque meal, and when an interval of eight hours has elapsed this opacity has left the ileum and is contained altogether by the colon. Entering the latter intermittently, it drops into the cæcum, gradually filling it and the appendix. The ascending colon becomes progressively distended, and eventually a wave of peristalsis arises which drives some of the chyme into the transverse colon. This initiates waves of anti-peristalsis which, starting in the proximal part of the transversum, pass down the ascending colon, distending the cæcum and appendix, and inaugurating new forward waves of peristalsis. These finally succeed in carrying the food into the distal transversum. The advancing wave reaches the latter in six hours, the splenic flexure in nine, and the brim of the pelvis or ilio-pelvic junction in eleven hours. Practically the whole of the bismuth may be collected within the distal part of the pelvic colon and the superior or pelvic chamber of the rectum after eighteen hours. In this situation it forms a large ovoid mass—*the pelvic residuum.* The greatest length of the opacity is reached about the twelfth hour. It then appears continuous nearly as far as the umbilicus; beyond this point it is discontinuous, and forms short, separate fragments. Retrograde movements are most common in the ascendens, but they have been observed also near the termination of the distal transversum, and at the commencement of the pelvic colon. Although the major part of the bismuth after twenty-four hours has accumulated within the recto-pelvic junction, we may still find traces within the cæco-ascendens, the transversum, and the descendens.

II. *Divisions of the large bowel.*—The large bowel is divisible into two sections, (*a*) proximal and (*b*) distal. The proximal, consisting of the cæco-ascendens, appendix, and the first few inches of the transversum, possesses digestive and absorptive functions. The distal is subdivided again into (1) the remainder of the transversum with the descendo-iliac colon, (2) the pelvic colon, with the superior pelvic chamber of the rectum, and (3) the perineal chamber of the rectum and anal canal. The first is a propelling or transmitting segment, the second serves as a magazine for the storage of the undigested residue of the food, while the third plays the part of a duct. The second and third subdivisions are practically separated by the chief rectal valve (plica transversalis), which is rarely visible in opaque radiograms, but is often seen when the rectum contains air and the photographic plate is placed over the sacrum.

III. *Variations from the mean.*—The figures we have already given must be considered average numbers (*orthokinesis*), since the progression may fluctuate widely in either direction and still remain within physiological limits. There are individuals in whom, as a general rule, an evacuation occurs twice or three times a day, certainly always after the principal meals, breakfast and dinner. They are quite healthy people, in whom a failure of the act twice a day becomes a source of anxiety. In cases of inguinal colotomy it is well known that the large bowel usually discharges a movement at least three times a day; so that the single daily stool, after breakfast, of the ordinary man, represents the fusion of at least three pelvic residues. The diagrams 1 and 2 represent the four-hour and eight-hour pictures of an individual who is accustomed to two or three daily evacuations. It is obvious that there must be a rapid emptying of the stomach, and a quick passage through the small bowel, since the opacity has reached the middle of the transversum within four hours. At the eighth hour the pelvic colon is filled, the small bowel is empty, the appendix invisible. The descendens, too, is free. The pelvic colon is short, and occupies the left half of the cavity. It may therefore be termed a *lævo-pelvic* colon. This type of pelvic colon appears, as one might expect, to be more prone to the formation of diverticula. In this variety, therefore, there is an increase of speed throughout the colon (*tachykinesis*). In the opposite condition, which may be termed *bradykinesis*, the opaque column passes slowly, in a continuous and undivided manner, around the splenic flexure, filling the descendo-iliac colon, and reaching the pelvic colon several hours behind the usual time. In the radiogram (Fig. 3), taken twenty-four hours after the meal, the discontinuity first appears when the pelvic colon is reached. Moreover, the latter is a *dextro-pelvic colon.* In some individuals the colon, with the sigma, appears longer than the average (*macrocolia*) ; in others a condition of *brachycolia* is present. Obviously there would be delay in the former. A slow unsegmented flow might finally lead either to the production of diffuse atonic constipation (colostasis atonica), or to the signs of hypertonic stasis.

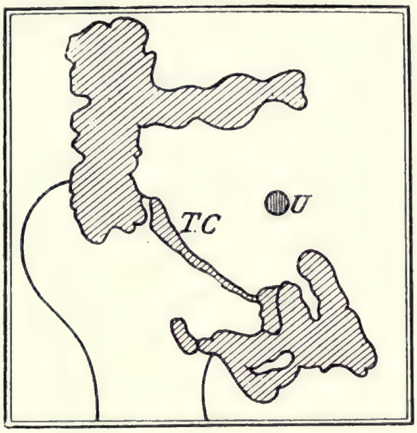

Fig. 1. 4 hours after bismuth meal. TC. Terminal coil of ileum. U. Umbilicus.

IV. *The clinical Anatomy and Physiology of the Colon.*—It is necessary here to refer briefly to a few points of radiological interest in this connection. The longitudinal muscular layer is thicker in three situations, forming three longitudinal bands—the *tæniæ coli*. The bands are about one-sixth shorter than the colon itself, consequently the latter is thrown into pouches or *haustra*, with intervening folds or constrictions (*plicæ semilunares*), in which all the layers participate. Three rows are naturally produced. If the tæniæ are removed, the haustra disappear, the colon becomes cylindrical and increases in length. The saccules, or haustra, also vanish when the tæniæ are passively stretched and elongated by the pressure of an opaque enema. A few finger-breadths from the hepatic flexure there is found a valvular thickening of the muscular wall which plays the part of a pylorus to the cæco-ascendens. In the latter type of constipation the opaque shadow may be *blocked* at this point for several hours, even days (Fig. 4). Occasionally a valve containing muscular fibres is found at the commencement of the descending colon. The proximal colon is concerned with the utilisation of the cellulose residue of the food. At no time does the cæcum of an animal become quite empty: when death takes place from starvation the cæcum and adjacent ascendens retain their normal contents. These facts agree with experimental results which tend to show that the vagus terminates at the ileocolic region, while the sacral nerve (*nervus pelvicus*) supplies the distal colon and rectum. In other words, the cæco-ascendens is devoid of motor nerves entirely. If true, we must look upon the ileocolic nodal tissue, with its vagus fibres, as the real motor centre for the ascending colon, although fibres from the right vagus may possibly reach the latter by way of the solar plexus. The sympathetic nerve supply is derived from the mesenteric plexuses, the superior splanchnic supplying the proximal, the inferior the distal colon and rectum. Between the muscular layers lies the myenteric plexus, consisting of ganglion cells, nerve fibres (afferent and efferent), and *intermediate* cells (1). These intermediate cells are connected by branches with unstriped muscle fibres on the one hand, and with true ganglion cells on the other. At certain situations, as

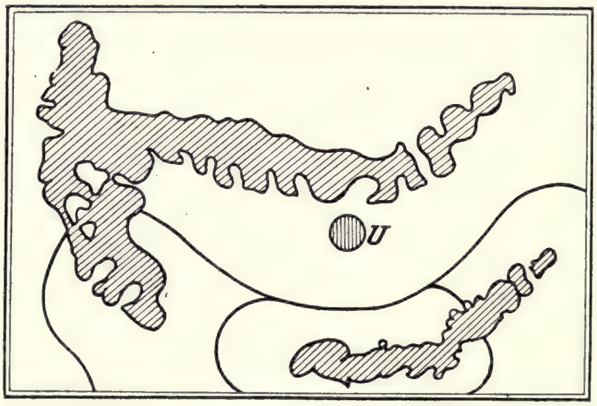

FIG. 2. 8½ hours. The bismuth has reached the recto-pelvic junction. The ascendens, transversum, and pelvic colon filled. Descendens empty.

the ileocolic area, the intermediate cells are numerous, and form a centre comparable to the nodal tissue of the heart. It has been suggested that the ileocolic node acts as a pacemaker for the peristaltic contractions of the ascending and proximal transverse colon. The distal colon and rectum contain an abundance of intermediate or nodal cells, but there is no special accumulation of such tissue. Long and short reflex arcs, provided by the vagus, pelvic, and splanchnic nerves, ensure the connection of the plexus with the collateral ganglia, the cord, medulla, optic thalamus, and cortex. There is an efficient sphincteric mechanism in the terminal ileum. There are others less efficient, but which produce delay in the near and distant parts of the transversum—already mentioned—and also at the ilio-pelvic junction, the real nature of which requires elucidation.

V. *The movements of the Colon.*—(*a*) On the screen, to the naked eye, apart from the passive movements due to respiration, the opaque colon is perfectly motionless. But if radiograms are taken at intervals of ten minutes, an incessant change in the outlines of the shadow may be perceived. This accounts for the blurring of the shadow often seen with exposures lasting more than a few seconds; while the margins of the metal disc placed over the umbilicus remain quite distinct, and show that respiratory disturbance has been absent. The excursions are minimal, are due to contractions of the circular muscle, and serve for the kneading, mixing, and churning of the contents. In the lower mammals these rhythmic contractions occur at the rate of about twelve times per minute. They possess *no directive power*, although they may exhibit periodic augmentation. Whether they are purely myogenic, or myoneurogenic in origin (in the latter case dependent on the activity of the myenteric plexus), is still *sub judice.* If they are to be ascribed to the latter, this plexus, as we shall presently see, must be endowed with a double rhythm. They have been named small, continuous, segmental movements.

(*b*) The anterograde movement of the chyme is due to a true peristalsis, that is to a wave of contraction preceded in front by a wave of dilatation. This has been termed *diastalsis.* The contractions occur at the rate of one or two per minute, and are attributed to the nodal tissue, since, in the lower mammals they are abolished by nicotin and curare. They correspond, apparently, to what has been recently termed *isomorphous haustration.* Although invisible to the naked eye, if the patient be examined again at an interval of an hour, an advance of the shadow may be detected, even if neither food nor drink has been taken in the meantime. Seeing that they must be accompanied by a dilatation in front, they may be termed *microdiastaltic* movements.

(*c*) In addition to the above there is a third, which is associated with the transport of the chyme over a considerable distance of the colon. These have been designated movements *en masse*, or sporadic large movements. They generally occur after the larger meals, and are obviously closely connected with the inception of food and the evacuation of the bowel. As such they will take place at least three times a day, and they appear to last only a few seconds on each occasion. On this account they are rarely seen. Now the vagus—possibly the pelvic nerve also—contains two sets of fibres, one *inhibitory*, with a short latency of one second, and a second, *augmentor*, with a latent period above ten seconds. The initial inhibiting effect is produced equally on both longitudinal and circular muscular coats; the subsequent augmentation is confined to the circular muscle alone. We can therefore understand the phenomena presented by the movement *en masse*. First an ovoid or sausage-shaped figure appears, in which haustral segmentation vanishes; this is obviously a result of the relaxation of longitudinal fibres. The advancing margin is broad, and tapers off gradually. Within it a ring or annular constriction becomes visible, which pursues the dilatation and drives the contents forwards. Behind it a very thin line of bismuth may be left—the expression of a small constricted lumen. This is obviously produced by the contraction of the circular fibres. As the wave ceases, the longitudinal fibres pass again into the usual tonic condition and the haustra reappear. They may be termed *megadiastaltic* movements. We may assume that the movement for the ascending colon and proximal transversum will start at the ileocolic node, as the result of a gastro-colic or recto-colic reflex from the sympathetic *via* the vago-pelvic nerve. With its retinacula or some residue of the sphincteric tract of the lower mammalia, the valve will provide a *point d'appui*. If it is essential that the cæcum should never be completely evacuated, the megadiastaltic activity should commence at the level of the valve, and leave the body and tip of the cæcum free. The wave would increase in amplitude and intensity as it approaches the hepatic flexure, just as gastric movements commencing beneath the fornix or air-reservoir become more obvious as they reach the pyloric half of the stomach. Also, the megadiastaltic movement has been seen to start near the end of the transverse colon and sweep the contents round the splenic flexure, down the descendo-iliac into the pelvic colon. Possibly this is due to the reflex activity of the pelvic nerve. For rapid transit there must be co-ordination between the vagus and pelvic nerves. These nerves are connected with the proximal and distal rhythmical zones of the colon respectively. Movements of a similar nature may be readily observed by the injection of salt or soap enemata containing barium.

(*d*) The occurrence of *anti-peristaltic* movements in man as a physiological actuality is still a matter of doubt. According to Case (2), whose opportunities of observation have been unique, they appear to start at the sphincter in the transversum already mentioned, and to pass down the ascendens towards the cæcum. Indirect evidence has been adduced as to their existence in the distal colon. If the statement of Case be verified, namely, that they *correspond in all but direction* to the movements *en masse*, anastalsis in man must be a true reverse peristalsis, and must differ from the movement in the lower mammalia. The frequency of anastalsis in the proximal colon must promote the function of the latter as an organ of digestion and absorption. Moreover, just as there are meganastaltic movements, there may be microanastaltic also. The

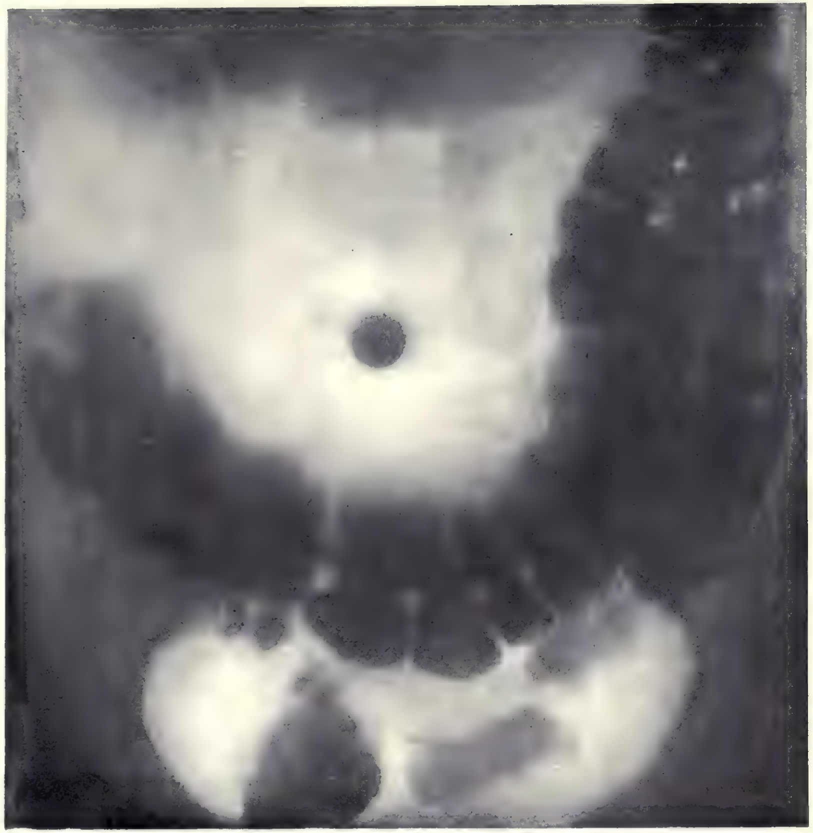

FIG. 3 24 hours after bismuth meal. There is no separation of the bismuth column until the pelvic colon is reached. The appendix had been removed some months previously.

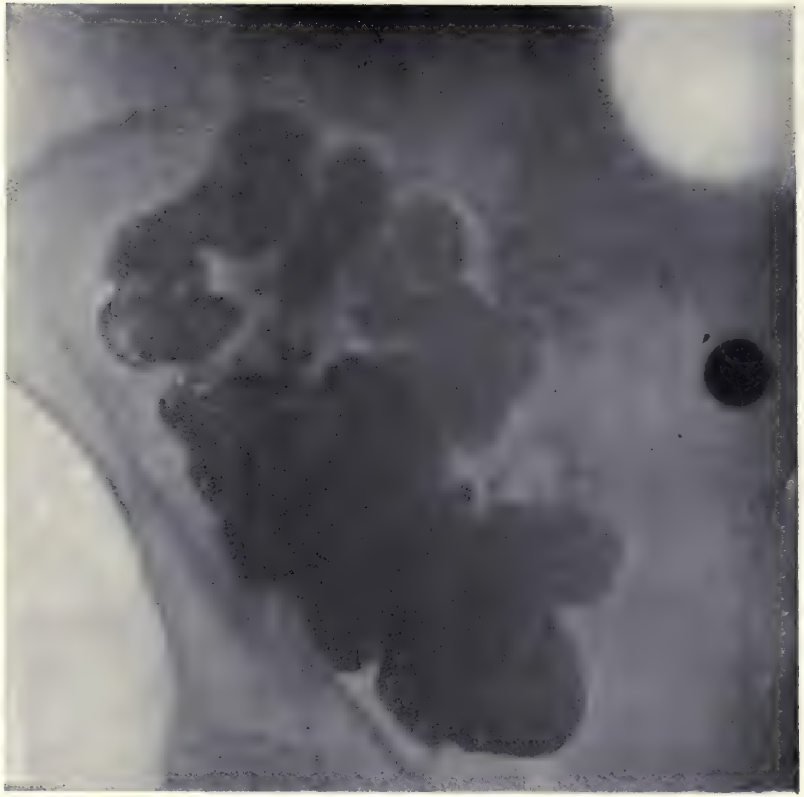

FIG. 4. 24 hours after bismuth meal. There is stasis in the ascending colon and first part of the transverse. Note the low position of the hepatic flexure, the appendix, and the situation of the block, about half way between the hepatic flexure and the umbilicus.

PLATE 31 illustrates "On the Movements of the Colon" by HUGH WALSHAM, M.A., M.D. (Cantab.), F.R.C.P., and WALKER OVEREND, M.A., M.D. (Oxon).

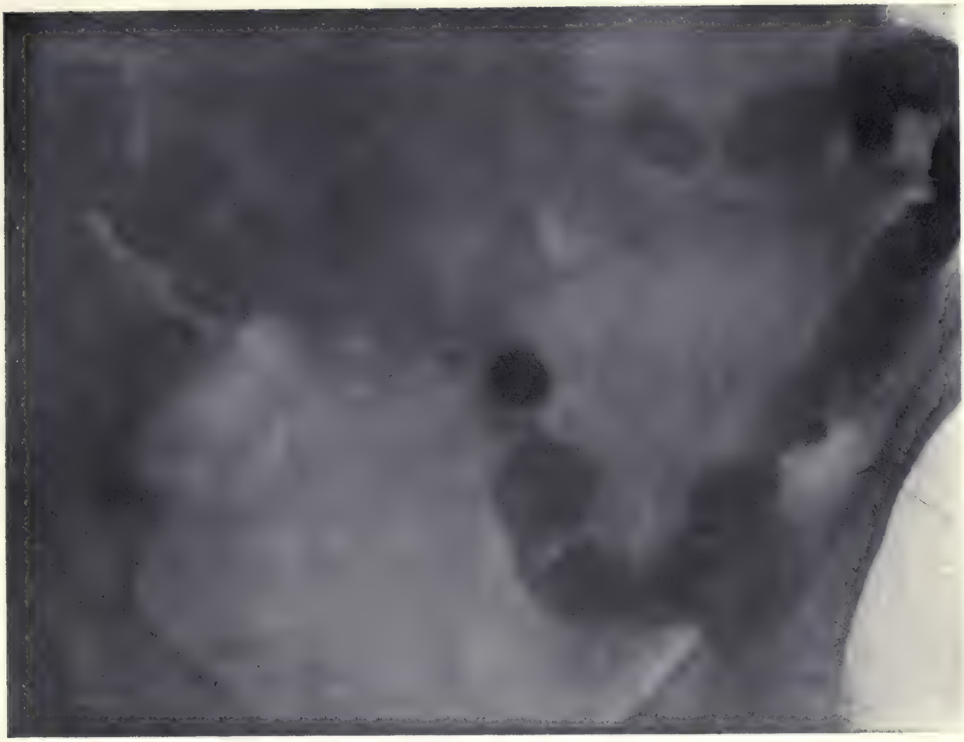

FIG. 5. 48 hours after bismuth meal. Note the direction of transverse colon and splenic loop at splenic flexure.

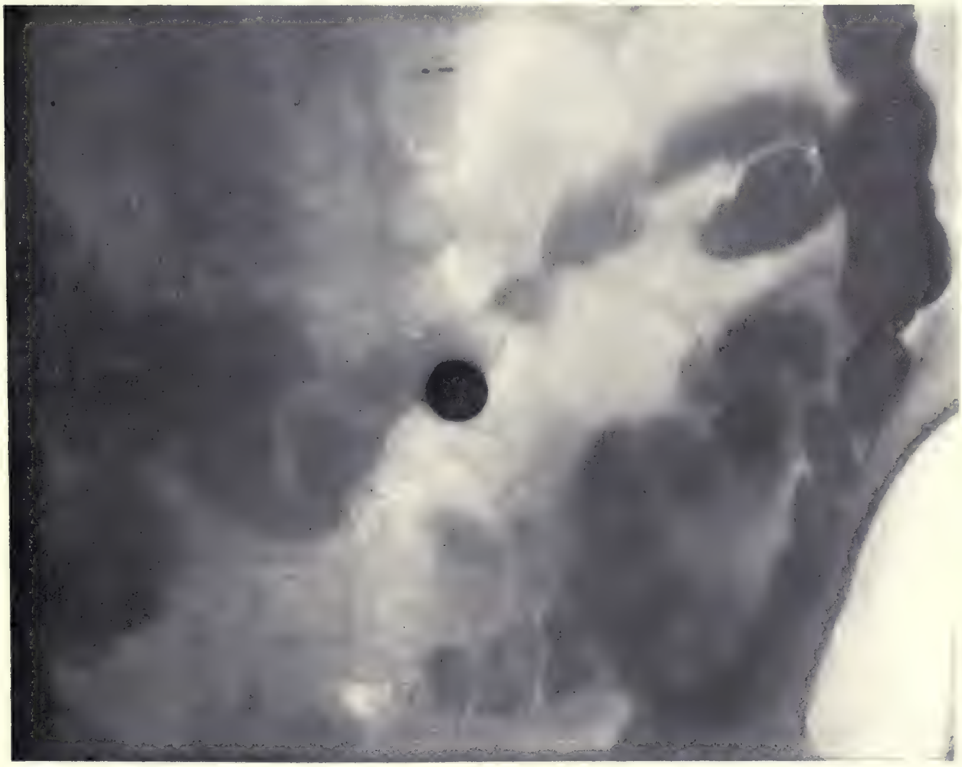

FIG. 6. 72 hours after bismuth meal. Note the altered direction of the transverse colon, also sigmoid loop parallel to the iliac colon. Figures 4, 5, 6, from the same individual.

PLATE 32 illustrates "On the Movements of the Colon" by HUGH WALSHAM, M.A., M.D. (Cantab.), F.R C.P., and WALKER OVEREND, M.A., M.D. (Oxon.).

formation of these movements will depend on the presence of a higher potential within a distal nodal area (3). Anastalsis, when exaggerated, is a sign of obstruction lower down, accompanied by an increased excitability of myenteric tissue in the same locality, and must therefore be expected to occur frequently in spastic constipation and in stenosis due to innocent or malignant growths.

(*e*) A fifth variety is seen in the large *pendular or swinging movement.* Occasionally radiograms are obtained in which, although the patient has been photographed exactly under the same conditions as before, the situation of the transverse colon differs considerably in the two. In Fig. 5 the colon beyond the umbilicus runs downwards ; in Fig. 6—taken after an interval of twenty-four hours—the direction is upwards. There may be a possible mechanical explanation of this alteration of site, a solution which explains the varying position in the same individual, at different times, of a "floating" sigmoid, as seen by the opaque enema. On the other hand the deviation may be produced by spasm, or relaxation of the bands of unstriped muscle which run in the folds of the mesocolon.

VI. *Conclusion.*—With regard to the two functional variations from the average progression of the opaque meal, the tachykinetic modification may be due to an increase in the number and amplitude of the megadiastaltic waves (vago-pelvic hypertonia) and probably associated with a reduction of anastalsis.

In the second type—bradykinesis—if it is not justifiable to assume the entire absence of megadiastalsis, we may at least maintain that it is slight and subordinate. There may be a diminution of tone in the vago-pelvic, an increase in the excitability of the splanchnic nerve (sympathetic hypertonia) or an increased production of adrenin, which reduces the activity of the vagus nerve. Since the haustra appear well defined, we cannot claim inefficiency, atrophy, or relaxation of the longtitudinal layer. The relationship of these two classes to the conditions of brachycolia and macrocolia, and to the herbivorous and carnivorous types of mankind (4), is at present indefinite and a subject for future investigation.

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A METHOD OF RECORDING RADIUM DOSES.

ILLUSTRATED BY A SERIES OF ELEVEN CASES TREATED WITH ONE SET OF RADIUM EMANATION CAPILLARIES IN NEEDLES.*

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It is an obvious advantage in treating patients with radium to have an uniform method of recording the dose. Only by adopting some convention in this respect can confusion be avoided, and the experience of one worker be utilized as a guide to others who are undertaking this kind of treatment.

It is convenient to speak of the "dose of radium," though the therapeutic effects are not due to radium or emanation, but to the β and γ rays given off by their descendants, radium B and radium C, during their conversion to radium C and radium D respectively. It is immaterial therefore whether the local source of the therapeutic rays is a radium salt or radium emanation. For our purpose the difference is principally that radium is practically a constant source of therapeutic rays, while the quantity of therapeutic rays from emanation decreases at the same rate as the emanation decays (see Table I). The quantity of radium is estimated by an electroscope which takes cognizance only of the rays from radium C. One millicurie of radium emanation and one milligramme of radium element are in equilibrium. They will discharge an electroscope at the same rate and give off the same quantity of therapeutic rays. In both cases there is the same amount of emanation, radium A, B and C present. It is necessary to remember, however, that emanation, when it is pumped off from the parent radium and sealed in a tube, takes four hours to reach its maximum activity, that is it takes four hours for the radium C, which is in equilibrium with the emanation present, to collect. After four hours the emanation and radium C remain at equilibrium, as both decrease at what may be regarded, for practical purposes, as the same rate.

It would be convenient, and avoid the possibility of confusion, if the quantity of therapeutic agents were at all times specified in terms of the element radium or in millicuries. Then X milligrammes of radium or X millicuries can only indicate the same definite quantity of therapeutic rays. At present this is not the case. The activity of radium or emanation is frequently given in terms of one of the radium salts. It is therefore necessary to know what standard is in use in measuring supplies from different sources. For instance, the international radium standard is $Ra\,Cl_2 2$. The standard used in the Radium Institute, London, is hydrated radium bromide ($Ra\,Br_2, 2H_2O$). Emanation is now supplied in Dublin in millicuries, though at the time I was carrying out my investigation on the practicability of the use of radium emanation needles, the Royal Dublin Society used my radium bromide standard in estimating the dose they were good enough to supply to me for the purpose.

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*A paper read before the Section of Surgery, Royal Academy of Medicine in Ireland, November 5th, 1915.

The following quantities of radium and its salts, and the amount of emanation in equilibrium with each, have the same activity, as can be calculated from their atomic weights.

100 mg. Ra (pure radium element).
147.4 mg. $Ra\ Cl_2\ 2H_2O$.
131.5 mg. $Ra\ Cl_2$.
142.5 m.g. $Ra\ SO_4$.
181.0 mg. $Ra\ Br_2\ 2H^2O$.
172.3 mg. $Ra\ Br_2$

It is apparent, therefore, that 100 millicuries is nearly twice as active as the amount of emanation in equilibrium with 100 mg. of $Ra\ Br_2$, $2H_2O$, the standard generally used in London.

The dose of radium depends on the two main factors. The amount of radium in use and the length of the exposure. Turner suggests, in the *Lancet*, December 26th, 1909, that the dose should be given in milligramme-hours—the number of milligrammes multiplied by the number of hours of exposure. This term has not been generally accepted. As it stands, it is too vague and inexplicit. To begin with, the milligramme standard varies. Turner uses pure radium bromide as his. Again, two identical doses may give very different results, as if 200 mg. of radium be used for one and a quarter hours, and five milligrammes used for fifty hours, the amount of radiation would be the same, viz., 250 mgh., but the effect on the tissues would probably be very different. In this connection Lazarus Barlow has carried out a series of highly important experiments. I quote as an example from page 53, "Archives of Middlesex Hospital," Vol. XXXIII :—

"But the experiments show with the greatest clearness that the same arrangement of time and quantity in radium dose produces very different effects when acting upon the three types of epithelial tissues (considered as complexes). Hence, the optimum arrangement of radium dose for the treatment of a columnar cell carcinoma, with its attendant tissues, is different from the optimum arrangement for treating a carcinoma of a dry squamous epithelium, with its attendant tissues. The experiments show that maximal effects on the epithelial cells and minimal effects upon the associated tissues are produced in the case of a columnar cell growth, when the quantity of radium is relatively great and length of exposure of the tissue is relatively small, but is produced, in the case of a dry squamous cell growth, when the quantity of radium is smaller and the length of exposure to the rays is increased."

However, I think there is a good deal to be said for the terms milligramme-hours or millicurie-hours. It saves circumlocution, and is quite explicit provided :—

1. The milligrammes are stated in terms of pure radium.
2. Emanation is stated in millicuries.
3. The quantity factor and time factor are recorded in the order indicated by the term milligramme-hours.
4. The dose is registered in the form of an equation.

Thus, when a patient received 12 × 10 = 120 mgh., it is clear that he had been treated by 12 mg. of Ra buried in the tissues for ten hours. If the radium is used on the surface the result is divided by 2, as at least half the rays are wasted, and the dose is recorded thus:—12/2 × 10 = 60 mgh. While in a structure where the whole circumference is radiated, as in an annular cancer of the rectum, 12/1 × 10 = 120 mgh., explains the dose and the method. It would be an advantage also to record the amount of screening. This might be done thus, 12 × 10 = 120 mgh/1.5 mm. Pb, as the dose is diminished by the rays intercepted by 1.5 mm. thickness of lead.

The term "millicurie-hours" makes it plain that emanation is the source of radiation. The definition of a millicurie leaves no doubt as to the standard used. When using emanation, however, as its activity decreases comparatively rapidly, the quantity factor of the dose must be calculated from an emanation table. It is about the mean of the initial and final amount of emanation present. It is more accurate and usually more convenient to state the quantity as that present when half the exposure is over. It is obvious that when a dose runs into days it would be better to take the mean of the quantities present at every six or twelve hours interval. I find the millicurie-hour a particularly convenient method of recording the dose when using emanation needles—as the needles are standard bore and thickness—namely, 7 mm. in bore and 4 mm. in thickness, and the screening is always the same, 4 mm. of steel. The capillaries also are of standard capacity and length, one cubic millimetre and 1.5 centimetre respectively. Therefore, each capillary of a set will contain approximately the same quantity of emanation.

The number of needles or foci of radiation is recorded in brackets. Thus, 12 (4) 10 = 120 mch. indicate that four needles containing an average total of 12 millicuries, or 12 millicuries at half the period of treatment, were inserted into the tissues for ten hours, and it is obvious also that each of the four foci contained 3 millicuries. Incidentally I may mention that when using the needles the roughest outline sketch, which is made in two or three minutes, graphically shows the relative position of the needles, their distance apart, and the size, shape, and locality of the area treated. By this means, with the minimum waste of time and energy, a complete record of the dose and treatment is secured, an essential for future reference. When sufficient, such record, accompanied by an account of the histological and clinical results of treatment are available, it will enable the question of dosage in radium therapy to be placed on a scientific basis.

In planning the treatment to be undertaken by the use of capillaries I find it an advantage to proceed on certain lines. Cases where there is evidence to show that short exposure with a large amount of radium gives the best results, are treated first. Again, I endeavour to use fresh capillaries in such position as in the throat and mouth, where a long exposure is trying to the patient. In my experience secondary malignant glands seem to benefit most by small quantities. With the glands too the risk of over-exposure is thus lessened. Small growths, where the needles are inserted very close together, can legitimately be dealt with small quantities, and rodent ulcers are particularly benefited by long exposure with small quantities. It is usually safer to use small quantities also where a dose is being repeated.

Besides illustrating dosage, the following account is intended to furnish an example of the amount and variety of work that can be accomplished by a single set of emanation capillaries. The cases, eleven in number, and all inoperable are not selected, but are simply those which happened to be ready for the dose of radium at the time I was able to procure it. They were treated by nine capillaries containing radium emanation which reached its maximum activity of 37.7 millicuries at 4.1 p.m. on the 4th June last, and which was supplied to me by the Royal Dublin Society Radium Institute. I may mention, one patient with malignant tonsil I had arranged to treat, died while I was waiting for it, and the second, a rodent ulcer, failed to keep his appointment.

The series is typical of the routine I have adopted, and well illustrates the economical use of the valuable therapeutical agent. I am not at present concerning myself with the efficiency of the method, described before (1), and employed by me for over a year and a half, in which a number of glass capillaries containing emanation are buried in the tissues included in the lumen of fine exploring needles. Besides being extensively used in Dublin, radium emanation capillaries in needles are now, Professor Joly informs me, largely employed at the Manchester Radium Institute, which is under the direction of Professor Rutherford ; and I know arrangements have been made by Dr. Russell to have them supplied at the Glasgow Radium Institute, where Mr. Fleck is in charge. Judging by the results that have been shown here, and published by others who have followed this technique, I think it may be claimed the procedure has a good deal to recommend it. It has been proved, I take it, that the method is not fraught with undue risks of over-exposure and sloughing owing to inefficient screening and secondary rays from the metal, as was suggested at the British Medical Association Meeting last year. I have already pointed out in this section (2) that screening in radiotherapy is only a means of securing uniformity of radiation, which uniformity is secured in this method, with the minimum waste of therapeutic rays, by the sub-division of the dose into "multiple foci of illumination," as suggested by Professor Joly.

The following is a summary of the patients treated, and contains particulars of disease, time of radiation, and dose. The dose is recorded as suggested in the beginning of this paper. For instance, 36.04 (9) 10 = 360.4 mch. indicates that the mean quantity of emanation employed or the amount of emanation at half-time in the treatment was 36.04 millicuries, that nine needles or foci of radiation were used, and the duration of the exposure was ten hours, while 360.4 millicurie-hours conveys an idea of the dose administered, and is a convenient record of the total amount of ionization effected.

SUMMARY.

Patient (1). Recurrent cancer of rectum. Time—5 p.m., 4/6/15. Dose—36.04 (9) 10 = 360.4 mch.

Patient (2). Cancer of root of tongue and epiglottis. Time—2 p.m., 5/6/15, to 1 a.m., 6/6/15. Dose—3.404 (1) 11=37.44 mch. Root of tongue and epiglottis. Time—1 a.m. to 10 a,m., 6/6/15. Dose—9.45 (3) 9=85.1 mch. Total, 112.54 mch.

Patient (3). Epithelioma palate. Time—2 p.m. to 7 p.m., 5/6/15. Dose--20.86. (6) 5=104.3 mch.

Patient (4). Sarcoma cheek, right nostril, and naso-pharynx. Nose. Time—2 p.m., 5/6/15, to 11 a.m., 6/6/15. Dose—6.56/1 (2) 21=137 mch. Nasopharynx through palate. Time—1 a.m. to 10 a.m., 6/6/15. Dose—12/61 (4) 9=113.48 mch. Cheek. Time—8 p.m., 8/6/15, to 10 a.m., 9/6/15. Dose—11.23 (6) 14=157.5 mch. Total—407.78 mch.

Patient (5). Carcinoma ethmoidal cells, maxillary antrum and orbit. Time—1 p.m., 6/6/15, to 2 p.m., 7/6/15. Dose —24.51 (9) 25=612.78 mch.

Patient (6). Epithelioma vulva and glands in groin. Time—5 p.m., 7/6/15, to 8 a.m., 8/6/15. Dose--20.43 (9) 15=306.4 mch.

Patient (7). Malignant glands neck. Time—2 p.m., 8/6/15, to 2 p.m., 9/6/15. Dose—5.51 (3) 24=132.2 mch.

Patient (8). Epithelioma tongue. Time—2 p.m. to 6 p.m., 8/6/15. Dose—2.2 (6) 4=48.8 mch.

Patient (9). Sarcoma chin. Time—2 p.m. to 9 p.m., 9/6/15. Dose—10.06/2 (6) 7=35.21 mch.

Patient (10). Epithelioma of tongue with glands in neck. Time—3 p.m., 12/6/15, to 2 p.m., 13/6/15. Dose—7.35 (8) 23=169 mch.

Patient (11). Cancer rectum. Time, 3 p.m,, 13/6/15, to 2 p.m., 14/6/15. Dose—6.1/1 × 23=130.3 mch.

Patient (1) had been operated on about a year previously for cancer of the rectum. Some nodules had developed near the anus causing partial obstruction. These nodules diminished greatly in size as a result of my treatment. The capacity of the bowel was considerably increased, and the patient was able to evacuate the rectum more freely, so that colotomy was deferred, and is still not necessary. (26th December, 1915.)

Patient (2) had a greatly infiltrated epiglottis which threatened to choke him. The tissue was so friable that only one needle $1\frac{1}{4}$ inches long could be made to remain in position. To overcome this difficulty I inserted needles $2\frac{1}{4}$ inches long into the root of the tongue and the epiglottis from the surface, entering them just below and in front of the angle of the jaw, and guiding them into position by the aid of my finger in the throat. The capillaries, of course, were at the point of the needles. As a result of treatment Dr. Richard Hayes verified that the tumour of the epiglottis had melted away and the whole condition of the part was very much improved. This patient had a number of glands in the neck, and was in a very critical condition when I saw him. For a time the glands became smaller and the throat improved. He died about four months later with well marked cachexia.

Patient (3) had been treated twice previously by Dr. Murphy, of St. Vincent's Hospital, and myself. The original ulcer of the palate had completely disappeared. This treatment was undertaken for some extension along the fauces and apparently was successful in causing it to disappear.

Patient (4) had a tumour at the junction of the upper jaw and cheek, which was about the size of a pigeon's egg, and which greatly disfigured his face. His right nostril was almost completely blocked, and two or three days previous to treatment he had had a very severe hæmorrhage from this, as a result of which he was quite blanched. His naso-pharynx was also choked up with the growth. I first put two needles loosely into his right nostril, later four right through the soft palate into the growth of the naso-pharynx, and later still six needles were inserted from inside the mouth into the tumour of the cheek. This was the second dose administered in the last region. This boy has not been treated since. His nostril and naso-pharynx have become quite clear, and Dr. Richard Hayes, who kindly examined him for me, found that the growth had completely disappeared from these regions. There is still a slight swelling of the cheek. The patient considers himself well, and he looks healthy. Up to the present I have considered it unnecessary to give him further treatment. This patient, whom you have seen here to-night, was this morning examined by Dr. Hayes and myself. A swelling was found near the right Eustachian tube. This has not affected his hearing, but will require further treatment. His right nostril is perfectly clear, in fact larger than normal, as the turbinated bones have atrophied.

Patient (5) has been operated on by Dr. Murphy, of St. Vincent's Hospital. He had considerable swelling of the right cheek over the antrum of Highmore, and proptosis of the right eye, evidently due to growth in the orbit. Six needles were inserted into the orbit, three along its inner margin, three along its lower margin, and three into the antrum through the cheek. As a result of this and a previous dose a marked depression developed over the antrum Highmore due to atrophy of the growth. The tumour of the orbit diminished, and the pain was greatly relieved. He returned to work. When I last saw the patient there were a couple of sinuses in the position where two needles had been. This patient refused further treatment, and I believe his condition has become considerably worse.

Patient (6) had an inoperable fungating epithelioma of the vulva which caused her great pain and discomfort, and bled frequently. She was treated in April, and improved so markedly that Dr. Alfred Smith, of St. Vincent's Hospital, was easily able to remove the growth. Dr. Smith kindly wrote to me, saying, "The progress of the case was most interesting. I look forward with much concern as to the ultimate result; there is no doubt as to the clinical cure, the future can only determine its permanency. She came to my ward a physical wreck. She returned home without any trace of the tumour, feeling and looking well." The present dose was intended as a prophylactic one. I am sorry to say this patient has now, after six months, apparently some return of her trouble, and is coming up from the country for further treatment.

Patient (7) was in a very bad way with ulcerated glands of the neck, and I do not think his condition was materially improved by the treatment on this occasion. A few months before he improved so much that he had gone back to work and neglected to attend me.

Patient (8) had a very chronic squamous epithelioma of the tongue, which Professor McWeeny—to whom I am much indebted for examining this and a number of other specimens—says has an extremely marked tendency to undergo keratinisation. This patient has been much improved by radium treatment. The glands under the jaw are much less evident. The mouth and tongue which were originally very foul have become clean. Treatment, especially any large dose, seems to cause the melting away of the tissue without producing a distinct slough. He has lost over half of the anterior third of his tongue.

Patient (9) has a sarcoma of the chin which had ulcerated through the skin. The tumour had considerably diminished with previous radium treatment. The needles in this case were inserted in line into a sterilized piece of lint and used by surface application on the ulcer.

Patient (10) appeared to derive great benefit from the treatment, but unfortunately I have since lost sight of him. When I first saw him he was hardly able to swallow fluid, a week after treatment he was able to eat meat. He stated that all the pain and soreness had gone from the root of the tongue where the disease was situated. Five needles were used in the glands; three long ones were inserted in the root of the tongue from the surface of the neck, in the same manner as in patient (2).

Patient (11) was an advanced case of cancer of the rectum. The treatment was employed to check the constant hæmorrhage, which it succeeded in doing to some extent. Soon afterwards he returned to the country. In this case the capillaries were fixed in the top of a thermometer case by paraffin, which was in turn surrounded by thin lead, and the whole tied in the finger of a rubber glove.

To sum up, it will be seen that these capillaries were utilized for ten days, till their activity was reduced from 37.7 millicuries to 6.2 millicuries. Eleven patients were treated and fourteen doses were administered. The parts treated were :—the orbit, the antrum of Highmore, the nose, the naso-pharynx, the cheek, the anterior part of the tongue, the root of the tongue, the palate and fauces, the epiglottis, glands in the neck and the groin, the vagina, and the rectum. The capillaries were used in short needles and in long needles ; they were buried in the tissues separately, employed for surface application, and collected into a single tube, according to the requirements of each case.

In conclusion, I do not think an account of any work with radium in Dublin is complete without expressing the indebtedness of the medical profession in this city to the Royal Dublin Society for the arrangements they have made for supplying radium emanation for the relief of suffering in the poor as well as in the rich. We who have used the capillaries recognize how much we owe to the skill and ungrudging labour of Mr. Moss, the Registrar, who, besides being the first to make them, had to devote a great deal of time in devising and setting up the apparatus for charging them with emanation.

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REPORTS OF SOCIETIES.

INTERIM REPORT OF THE COMMITTEE ON STANDARDISATION OF X-RAY DOSAGE.

Authorised to be printed in full by the Council at its Meeting, held on June 1st, 1915.

This Committee was constituted by the Council of the Röntgen Society in October, 1913, with the following personnel:

Chairman, ALFRED W. PORTER, D.Sc., F.R.S,;

Convener, ROBERT KNOX, M.D.;

Other members, W. DEANE BUTCHER, M.R.C.S., W. DUDDELL, F.R.S., N. S. FINZI, M.B., J. H. GARDINER, F.C.S., W. HAMPSON, M.A., G. W. C. KAYE, D.Sc., C. E. S. PHILLIPS, F.R.S.E., and SIDNEY RUSS, D.Sc.

This report is presented only as an interim one. It deals chiefly with existing practice and only gives occasional suggestions as to desirable modification in such practice. It is felt that more experimental work is still needed before this can be done successfully. Some has already been undertaken, but owing to present war conditions has been interfered with. Meanwhile it has been decided to publish the information which has been so far collected, in the hope that it may be made the basis of discussion and investigation by the members of the Society and others.

GENERAL.

The output of an X-ray tube must be specified with respect to—

(1) Quality or hardness, and

(2) Intensity or quantity per sq. cm. of the receiving surface.

The one is as important as the other in both radiography and therapeutic treatment.

The rays from a bulb may be divided into two classes, of which the proportions depend on the conditions.

(1) The "general" or "independent" or "non-characteristic" X rays which are heterogeneous and depend in quality solely on the speed of the parent cathode rays.

(2) The "monochromatic" or characteristic X rays which are homogeneous and characteristic of the metal of the anticathode.

I.—METHODS OF MEASURING QUALITY OR HARDNESS.

The hardness of the rays from a particular bulb is mainly dependent on the potential difference between the electrodes. There is some reason for believing that it is the maximum potential difference which is the important factor, but further experiments on this point are needed. There is a variety of methods of controlling this potential difference, *e.g.*, nature and pressure of gas, size and shape of bulb, nature and position of cathode, etc.

The potential difference between the electrodes controls the speed of the cathode rays.

The quality and energy of generul X rays depend on the speed of the exciting cathode rays, the energy being proportional to the fourth power of that speed.

In the case of the characteristic radiations, it is found that a certain minimum voltage on the tube is necessary to excite a particular radiation. The quality of these homogeneous radiations is defined rigorously by the nature of the anticathode.

The potential difference can be measured—

(1) By the length of the alternative spark gap.

(2) By a high potential electrostatic voltmeter.

Tables connecting spark gap and voltage for steady and alternating current have been obtained, and are appended to this report. But with the "discontinuous" potential curve of an induction coil, we need to know the shape and abruptness of the potential peaks, as well as the proportion of time between them, before we can estimate the effective potential. It is probable, however, that, at any rate with a hard tube, the spark gap gives a value not far from the maximum potential, though this again is an opinion not shared by all experimenters.

Unfortunately, it does not appear that two apparently similar bulbs which have the same spark gap will give equally hard rays, though this should be put to the test of careful experiment.

(1) *Wave length.*

For monochromatic rays the hardness or

penetrating power is precisely defined by the wave length ; the shorter the wave length, the harder the X-ray. Wave lengths can be compared by diffraction experiments with crystals. The hardness of a heterogeneous beam may be considered in terms of the average wave length of its component rays.

(2) *Absorption.*

The customary method of specifying the quality of X rays is to measure their absorption in some substance. Aluminium is usually chosen. If the conditions are such that, when 1, 2, 3, - - - - - - similar sheets are successively introduced into the path of the rays, each additional sheet is found to absorb the same fraction of what it receives then the rays are homogeneous.*

If λx is the fraction absorbed by a very thin layer x, then λ is defined as the *linear absorption coefficient.* The softer the rays, the larger the value of λ.

Some workers prefer to specify the thickness (d) which will reduce the intensity to half value.

d is connected with λ by the expression:—

$d = 0.693/\lambda$. which may be taken as $0.7/\lambda$.

It must be remembered that λ varies with the nature of the absorbing screen, so that it is necessary to specify the material used. Christen has recently suggested that water or some equivalent substance, such as bakelite, should be used for this purpose.

If we divide λ by the density, $/\rho$, of the absorbing screen, we obtain λ/ρ, the *mass absorption coefficient,* which gives a measure of the absorption per unit mass, and is more fundamental in conception.

If the absorbing powers of different materials were truly proportional to their densities, then for the same beam of X rays λ/ρ would be a constant, no matter what the substance used as screen. In point of fact, dense substances are a good deal more absorptive, mass for mass, than light substances, and λ/ρ increases rapidly with the atomic weight of the screen.

With ordinary heterogeneous rays, λ is greater for thin screens than for thick, and so we can only deal with an average λ, which, however, varies more and more slowly as the screen becomes thicker.

In the case of the characteristic radiations, an element exhibits a maximum transparency for each of its own characteristic radiations. For slightly harder rays than these, the rays characteristic of the screen are produced and superposed on the transmitted rays to an extent which diminishes as the incident rays are increasingly hardened. For incident rays softer than the critical type, no characteristic rays are produced. Thus, as the incident rays are gradually hardened, the transmitted rays reach a maximum intensity when the incident rays are of the same quality as each of the characteristic rays in turn.

The following is a list of some of the chief penetrometers in use at the present time:—

Penetrometers, etc.

Bauer (Electrostatic voltmeter).

Bauer Qualimeter. This serves to measure the potential difference between the electrodes of a tube, and so affords a definite reading of the hardness of the X rays.

Benoist Penetrometer. The Benoist penetrometer consists of a thin silver disc 0.11 mm. thick, surrounded by twelve numbered aluminium sectors from 1 to 12 mm. thick. The X rays are sent through the instrument, and the observations consist merely in matching on a fluorescent screen, or photographic plate, the image cast by the silver disc against the images of the aluminium plates; the thickness of the matching sector increases with the hardness of the rays.

Benoist based the theory of his instrument on some experiments of his own, which went to show that while the transparency of aluminium altered a good deal with the quality of the X rays, silver was almost equally transparent to both hard and soft rays. Later work, however, shows that the assumption of a constant transparency for silver is by no means correct.

Röntgen in his third memoir describes an instrument essentially similar, with the exception that the comparison metal was platinum instead of silver,

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* This is conditional on the X rays being neither scattered nor changed into another type of ray.

Christen's Half-value Penetrometer. Christen adopts as a definition of quality the thickness of a layer of water (or, in actual practice, bakelite), which will reduce the intensity of a beam of rays to half its original value.

The rays are sent through a stepped wedge of bakelite, alongside which is a perforated metal plate. This provides a standard of reference on a fluorescent screen, the two images being side by side. The holes in the plate are so designed that the area of the metal removed equals that which remains, so that the plate by this means reduces the intensity of a beam of rays to half-value. The holes are small enough to produce uniform illumination on a screen placed a short distance behind the plate.

Klingelfuss (Auxiliary search coil and electrostatic voltmeter). The Klingelfuss instrument works on a similar plan to the Bauer.

Walter Penetrometer. This consists of a number of holes in a lead disc, which are covered by a sequence of platinum discs of gradually increasing thickness.

Wehnelt Penetrometer agrees in principle with that of Benoist. An aluminium wedge is used instead of a series of stepped sectors.

Salamonson uses two aluminium wedges, one sliding over the other.

The Benoist and Wehnelt penetrometers involve the use of two metals and depend on the selective absorption by one of them (silver) of certain components of the X rays. The readings are thus likely to be affected greatly and irrationally by the composition of the beam as distinct from its average hardness as measured by some more rigorous and straightforward method.

II.—METHODS OF MEASURING INTENSITY.

The intensity is defined as the energy of the X rays falling on one sq. cm. of the receiving surface. The intensity of the rays from a focus-bulb falls off as the inverse square of the distance from the anticathode.

This intensity can be measured in various ways.

It may be noted that almost all the methods of measurement as ordinarily practised are unduly favourable to soft X rays when considered from an energy standpoint. The ideal method of test would afford an exact comparison of the energy of a hard X ray with that of a soft ray, but what almost always happens is that the hard rays are not wholly arrested by the testing instrument, and hence show up relatively badly.

(1) *By the current through an X-ray bulb.*

A rough comparative notion of the intensity of the X rays from a bulb may be obtained by measuring the current through the bulb, provided the potential difference is kept fairly constant. This method would be a more reliable guide if

(*a*) All the current were carried solely by the cathode rays and

(*b*) All the energy of the cathode rays became X-ray energy.

Further experimental work is needed to settle these points,

In view of the peculiar wave form of the pulsating current of a discharge, it is difficult to interpret the significance of the average reading afforded by a particular current measurer. Salamonson (*Journal Röntgen Society*, 1912) showed that the shape of the current curve as well as the frequency of the interruptions must be taken into account in exact comparative measurements. In fine, the milliampèremeter measures only the current passing through a bulb and not the X rays emitted by it.

(2) *Thermal methods of measuring intensity.*

Heat is produced when X rays are absorbed by a substance, but the effect is minute and can only be detected with great difficulty. It does not appear that the method is ever likely to be available for ordinary practice.

(3) *Ionisation methods of measuring intensity.*

An ionisation method of evaluating X rays resolves itself into the measurement of a small electric current—an operation capable of great sensitiveness. It is important that the conditions should be such that the saturation current is always generated and measured. The form of the apparatus chosen depends on what we wish to measure. If it is the total energy of the rays that is desired, then the rays must be completely absorbed in the gas of the ionisation chamber, which will have to be of special form. If, on the other hand, we merely wish to ascertain the ionising power of a beam of rays at some particular point, then almost any form of chamber will suffice.

Total Ionisation. Experiment seems to show that the total ionisation, as measured in a properly designed ionisation chamber, is a measure of the energy in the rays. The number of ions produced by the complete absorption of a beam of X rays in a gas has been found to be the same, no matter what the nature of the gas, so long as the characteristic radiations are not excited.

(4) *Photographic methods of measuring intensity.*

In common with the other methods of measuring intensity, a photographic plate gives undue weight, from an energy standpoint, to the softer rays of a heterogeneous beam.

Moreover, if the beam contains components which are capable of exciting the radiations of silver or of bromine (the two heaviest ingredients of the film), those particular X rays are selectively absorbed, and, owing to the resulting corpuscular rays, the photographic effect is greatly enhanced.

Thus the photographic action may not be proportional to the absorption of the X rays by the film.

There are also some practical uncertainties, as Mr. Gardiner has pointed out. These are due principally to variations in thickness of the emulsion owing largely to want of flatness of the plate.

Kienböck's quantimeter comes under this head, but uses photographic paper instead of a photographic plate.

(5) *Fluorescence methods of measuring intensity.*

This method also presents the difficulty of preferential treatment of the softer rays. In practice, the luminosity is matched against some standard fluorescence excited by a steady source of radiation such as radium. The drawbacks are :—

(*a*) The fatigue of the fluorescing salt.

(*b*) The varying sensitivity from point to point of a screen.

These difficulties might be lessened by the use of a rotating screen.

(6) *Chemical and other methods of measuring intensity.*

(*a*) The pastille of barium-platinocyanide. (Sabouraud-Noiré and Bordier, Holzknecht, Hampson, Lovibond.)

Barium Platinocyanide Pastille. The barium-platinocyanide discs are some 5 mm. in diameter, and their colour, initially a bright green, changes when exposed to the rays to a pale yellow, and finally to a deep orange. The pastille is placed at a specified distance from the anticathode of the bulb, and the colour is matched against one of a number of standard tints. The method is fairly reliable as a guide for short exposures, but it is not trustworthy for long exposures.

The pastille method is defective in that it attempts to measure rays of all qualities by a surface colouration.

(*b*) The liberation of iodine from a 2 per cent. solution of iodoform in chloroform. (Freund, Bordier and Galimard.)

(*c*) The discolouring of alkaline salts. (The original method of Holzknecht.)

(*d*) The precipitation of calomel from a mixture of mercuric chloride and ammonium oxalate. (Schwarz.)

(*e*) The lowering of the electrical resistance of selenium.

The table below gives the approximate sparking voltages in air at atmospheric pressure and room temperature. Too much reliance must not be placed on the figures, as the results of different experimenters do not agree well, probably owing to the difficulty of measuring the potential. The values for the needle-point electrodes are for alternating current of sine form, and are due to Steinmetz (*Proc. Amer. Inst. Elec. Eng.* 1898). For alternating currents, the striking distance is most probably governed by the maximum voltage, which is accordingly given in the table rather than the effective (root-mean-square) value. [=(max.) / 1·42.]

Table of Sparking Potentials.

Spark gap.		Diameter of Balls.				
		Needle-pts.	0·5 cm.	1 cm.	2 cm.	5 cm.
cm.	inch.	A.C. volts. (Max.)	D.C. volts.	D.C. volts.	D.C. volts.	D.C. volts.
0·1	·04	1,000	5,000	5,000	5,000	5,000
0·2	·08	2,000	8,000	8,000	8,000	9.000
0·3	·12	4,000	11,000	11,000	11,000	12,000
0·4	·16	5,000	14,000	14,000	14,000	15,000
0·5	·20	6,000	16,000	17,000	17,000	18,000
0·6	·24	7,000	17,000	20,000	20,000	21 000
0·7	·28	8,000	18,000	22,000	23,000	24,000
0·8	·31	10,000	19,000	24,000	26,000	27,000
0·9	·35	11,000	20,000	26,000	29,000	30,900
1	·39	12,000	21,000	27,000	31,000	33,900
2	·79	24,000	24,000	36,000	48,000	57,000
3	1·18	34,000	26,000	42,000	58,000	77,000
4	1·58	42,000	27,000	45,000	65,000	93,000
5	1·97	49,000	Brush discharge usually occurs.	47,000	71,000	105.000
6	2·36	55,000		Brush discharge usually occurs.	77,000	116,000
7	2·76	61,000			82,000	125,000
8	3·15	66,000			87,000	133,000
9	3·54	71,000			91,000	140,000
10	3·94	76,000			95,000	145.000
15	5·91	102,000			Brush discharge usually occurs.	170,000
20	7·9	122,000				190,000
30	11·8	170,000				—
40	15.8	220,000				—

For ball electrodes, the most recent and reliable measurements of the maximum spark potentials for alternating current come out about 5 per cent. smaller than those for direct current.[1] the values for which are given in the remaining columns of the table.[2] These latter results refer to smooth polished metal balls of the same size.

An inspection of the table shows that, in general, the spark passes more readily the smaller the ball; and that short spark gaps require proportionately more potential than long.

The measurements are taken in the absence of any visible brush discharge, a condition essential for definite sparking. It is better in practice to use moderately large balls than small, as with the latter brush discharge tends to occur, more especially at the negative pole: such glow is, of course, a prominent feature with needle-point electrodes. The needle-point spark gap often supplied with induction coils, while it enhances the apparent capabilities of the coil, is not suitable for measuring purposes. If unequal sized balls are used, the smaller electrode controls the spark gap for moderate lengths of spark: the larger ball should be made the negative electrode.

Trowbridge (*Phil. Mag.*, 1898) found a spark length of 200 cms. with a potential of 3,000,000 volts. With very long sparks, the shape of the electrodes (if of a moderate size) is immaterial. For instance, with a potential of 240,000 volts, Jona obtained the same sparking distance (47cms.), whether a point and plate or two balls (2 cms. diam.) were used.

COMPARISON OF X-RAY BULBS IN ACTUAL USE AT VARIOUS HOSPITALS

Several meetings of the Dosage Committee of the Röntgen Society having taken place during the first half of the year 1914, it was found necessary, in order that the objects of this Committee should be furthered, that some information be obtained of the radiation from the X-ray bulbs actually in clinical use at several of the hospitals in London. The main object of the work was to see whether the radiation emitted from bulbs running at the same spark gap in different institutions was essentially similar, and, if not, to what extent the differences were important. These tests were undertaken by Dr. Sidney Russ.

Facilities were generously provided at the first four hospitals approached, and measurements upon the lines indicated have been made in these cases; it is only appropriate that the thanks of the Society be conveyed to the officers in charge of the departments visited.

The method by which the tests were carried out was as follows:—A small gold-leaf electroscope, with walls of lead 4 mm. thick, was fitted with a thin aluminium window, about ·1 mm. thick, through which the rays from a bulb distant about 150 cm. were allowed to enter. The conditions were first adjusted so that the bulb was running as a "medium" tube; the character of the radiation was found by measuring its gradual absorption when increasing thicknesses of aluminium were placed in front of the window of the electroscope; tbe way in which this was done was to take two readings of the electroscope to obtain what may be called the zero, then to interpose a screen of aluminium of a certain thickness and take two readings, then remove the screen and take two more readings; in this way any sudden change in the output of the bulb was detected and allowed for in calculating the absorption which the beam of X rays suffered in going through any particular thickness of aluminium.

---

[1] Based largely on the results of Algermissen (*Annalen der Physik*, 1906) and Toepler (*Ann. d. Phys.*, 1907).

[2] See Kowalski and Rappel (*Phil. Mag.*, 1909), who employed balls up to 30 cms. diameter.

A series of such measurements having been made, the same, or another, X-ray bulb was adjusted so as to run as a "hard" bulb, and an exactly similar series of measurements conducted. This procedure was followed as closely as possible in all of the four hospitals, to be referred to in the text as A, B, C and D. Data were also obtained from "soft" bulbs, but this in only two cases.

The spark gap was measured between the metal points fitted upon the installations and (except in one case) between a parallel spark gap consisting of brass spheres, 5 cm. diameter, built to the design of Mr. J. H. Gardiner; by the use of spheres brush discharge is avoided. The current passing through the bulbs was measured on the existing milliammeters, which were subsequently checked by an instrument which had been gratuitously standardised by the National Physical Laboratory and kindly lent for the purpose in hand by Professor A. W. Porter.

The main features of these tests are exhibited in the curves of Fig. 1 and Fig. 2, the numerical data corresponding thereto being collected in Table 1 and Table 2. In these tables will be found the value (in arbitrary units) of the ionisation caused by the X rays after having passed through various thicknesses of aluminium. The logarithms of these values are plotted Fig. 1 and Fig. 2 in order to bring out the heterogeneous nature of the radiation in each case.

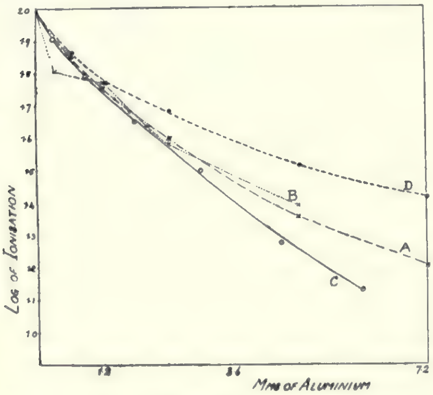

FIG. 1.

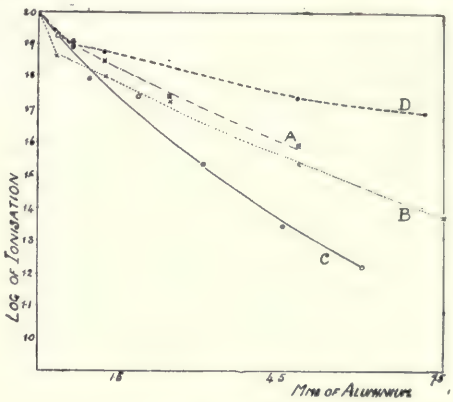

FIG. 2.

If the rays from the four bulbs under identical spark gap had been of the same character the four curves would all have overlapped. Two of them, A and B, are seen to be very similar for both of the spark gaps employed; the radiation from C and D is, however, widely dissimilar, C being about as much "softer" as D is "harder" than the other two.

It may be pointed out that these differences would be of most importance in the administration of "hard" rays. It is not unusual for the dose of "hard" rays to be measured by the colouring of a pastille exposed to the *unscreened* rays. Let us consider the case of two patients receiving a pastille dose of "hard" rays from bulbs C and D; if the pastilles exposed to the unscreened rays coloured to the standard tint in the same time, then the patient beneath bulb D would receive at least three times as much "hard" radiation as the one being treated by C.

Considerations of this kind indicate the necessity of measuring the radiation actually received by the patient.

The reasons for the large differences exhibited by the four bulbs are not apparent. The interrupters generally in use were the mercury jet and the mercury dipper. Upon one occasion the same bulb was run at the same spark gap first with one interrupter and then the other; the character of the rays was almost identical in the two cases as may be seen from the data in Table 3.

It seems not improbable that one must look upon the bulb itself as the main cause of the outstanding differences, and although not put forward here as a satisfactory explanation of the variations in question, it is worthy of note that of the two bulbs showing the widest variations, one (C) was fitted with a light anode which soon became red hot, the other (D) had a heavy anode which was kept cool by a metal radiator. All of the bulbs tested had platinum anodes.

TABLE 1.

"HOSPITALS TEST."

Absorption of Rays by Aluminium.

"Medium" Tube

Spark Gap :—4 cms. (spheres).
13·5 cms. (points).

IONISATION.

Thickness of Aluminium.	Hospital A	Hospital B	Hospital C	Hospital D
0	100	100	100	100
·3 mm.	—	64·2	81	—
·6	71	—	73·6	73·4
·9	—	—	61·6	—
1·2	58	59	—	59·1
1·8	—	—	44·8	—
2·4	40	36·6	—	49
3·0	—	—	31·7	—
4·5	—	—	18·9	—
4·8	23	25	—	33
6·0	—	—	13·5	—
7·2	16	—	—	26·3

TABLE 2.

"HOSPITALS TEST."

Absorption of Rays by Aluminium.

"Hard" Tube

Spark Gap :—6 cms. (spheres).
18·3 cms. (points).

IONISATION.

Thickness of Aluminium.	Hospital A	Hospital B	Hospital C	Hospital D
0	100	100	100	100
·3 mm.	—	74	87·5	—
·6	78·6	—	81·5	77·8
·9	—	—	62	—
1·2	71·4	64	—	75·4
1·8	—	—	54·9	—
2·4	55·6	53·4	—	72
3·0	—	—	34·1	—
4·5	—	—	22·1	—
4·8	39·5	34-3	—	54·8
6·0	—	—	16·7	—
7·2	—	—	—	49·2
7·5	—	23·5	—	—

"Soft" Tube

Spark Gap :—2 cms. (spheres).
8·3 cms. (points).

Thickness of Aluminium.	IONISATION. Hospital B.	Hospital D.
0	100	100
·3	74·8	—
·6	—	70
1·2	38·3	45·5
2·4	26·5	33
4·8	14·6	19·2

TABLE 3.

MERCURY JET AND MERCURY DIPPER BRAKE TESTS.

Same X-ray Bulb.

Aluminium.	IONISATION. Jet.	Dipper.
0	100	100
·6	71	76
1·2	58	57
2·4	40	39·4
4·8	23	22.9
7·2	16	15·1

THE COOLIDGE TUBE.

During the last year the Coolidge X-ray Tube has come into use. Some tests on such a tube have been made by Dr. Russ and published in the *Journal* of the Society (No. 43, Vol. XI.). The tube possesses many advantages, but until further tests are made the Council is not in a position to express a definite opinion upon it.

ENQUIRY COLUMN.

W. H. S.—In the ARCHIVES of May last, Dr. Case insists on the necessity of more accurate dosage of X rays, especially in using the Coolidge tube.

Dr. Szilard has described in the ARCHIVES of June, 1914, his iontoquantimeter, by which the quantity and quality of radiation may be accurately determined; and on page 18 he has given a series of numbers for doing so; but he has not shown the ratios these bear to our ordinary means of measurement. For instance, supposing one wishes to apply to a deep tumour one ma. with ten benoist and three mm. aluminium for ten minutes, how would you represent that amount of radiation in terms of Dr. Szilard's table? I take this example from your Table III., on page 56 of the ARCHIVES for July, 1915, for the sake of comparison.

[The data contained in Dr. Szilard's account of the iontoquantimeter do not give information sufficient to meet the enquiry. The standardisation of the instrument was carried out by means of definite amounts of radium, and despite several attempts which have been made, there is no satisfactory basis of representing the amount of radiation emitted by an X-ray bulb in terms of the radiation from a definite quantity of radium. The reason for this is that two X-ray bulbs, carrying the same current and working at the same potential difference, do not emit radiation which is identical in quality or quantity.]

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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RADIOGRAPHY OF NORMAL PARTS.

By Archibald McKendrick, F.R.C.S. (Edin.).

(*This work was carried out under the auspices of the Carnegie Research Fund.*)

(*Continued from page* 259.)

Knee Joint.—From the radiographic point of view, the knee joint may be considered as an anatomical hinge joint. It can be taken, therefore, antero-posteriorly, postero-anteriorly, and laterally from within or without. Laterally it can be X-rayed in any degree of flexion.

No advantage is to be gained in the postero-anterior view (with the patella in contact with the plate) except that the patella is, if anything, better defined in this position.

Antero-posterior view.—Normal position—knee straight and with the calf and back of thigh in contact with the plate, toes together. It should be noted that the level of the joint is just below the lower pole of the patella, and that the normal focus-point is therefore directly above this point.

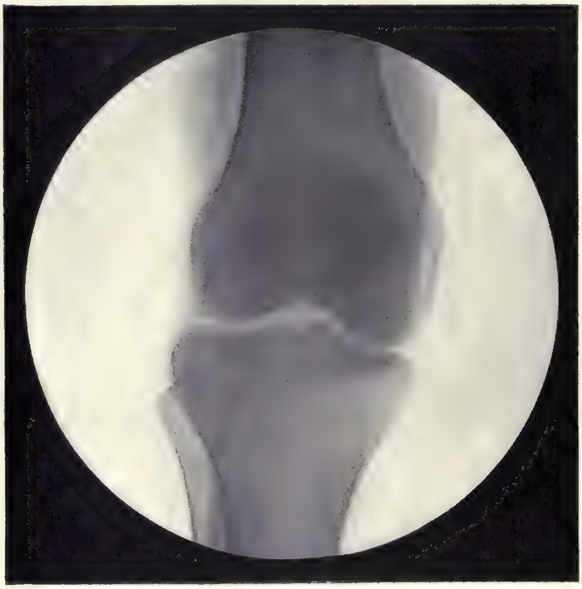

FIG. 21.

The reason for this choice of normal position (*i.e.* with the toes together, and pointing directly upwards to the ceiling) is that the superior tibio-fibular articulation is situated postero-externally. In the natural position of the limb with the toes turned outwards, the fibula comes to lie more posteriorly, and a radiograph taken in this position shows overlapping of the shadows of these

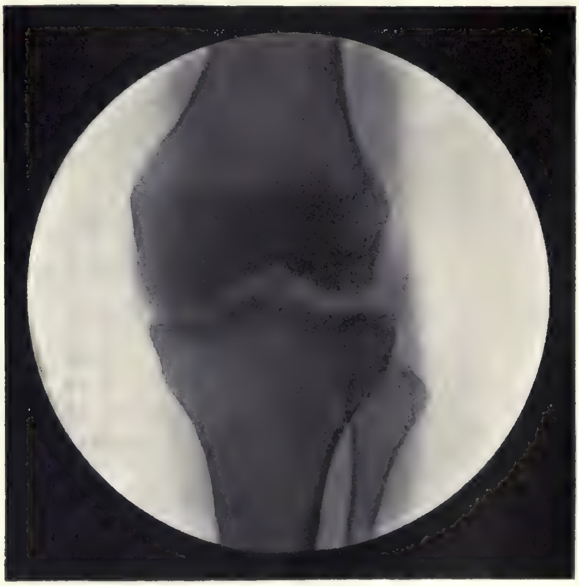

FIG. 22.

two bones. Besides, this normal position can always be reproduced. Fig. 21 is taken with the toes together and pointing directly upwards and the tube centred over the joint. Even here there is considerable overlapping. If a plate is taken with the tube centred directly over the centre of the patella, and not from the normal focus-point as in the case of Fig. 21, there is little difference.

Other plates may be taken postero-anteriorly with the tube centred over centre of the joint, four inches internal, and four inches external. These various focus-points only show the different relative position of fibula to tibia.

Radiographically there are always two spines showing at the upper end of the tibia. The inner of these is the true tibial spine. It is always better marked, and more clearly defined than the "false" spine. The false spine is the inner extremity of the external articular facet. Sometimes there is a third but smaller spine showing internal to these two. Anatomically this is a spur on the outer edge of the internal articular facet. It is situated anatomically, just anterior to the true tibial spine, and is not seen unless the limb has been at the time of the exposure in a position of internal rotation.

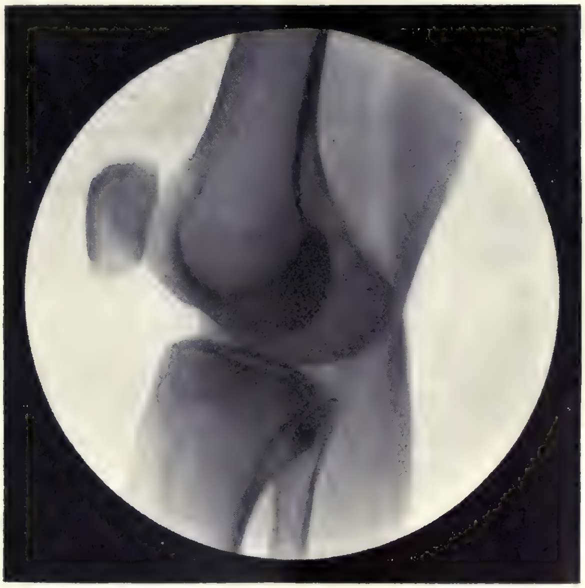

FIG. 23.

The upper articular surface of the tibia is an irregular oval. When the toes are together, the long axis of the oval is directed outwards and forwards. That is to say—a line drawn through the long axis of the ovals of both tibiæ will meet behind the knees if the toes and ankles are together.

When the toes are in the natural position of slight eversion these long axes are in the same straight line. Now, the superior tibio-fibular articulation is on the posterior aspect of the outer tuberosity of the tibia, and if the limb is in a position such that the toes point naturally outwards, or even in a position with the toes together, the shadows of the tibia and fibula are partially superimposed. The practical point is, that if it is desired to show the upper part of the fibula clearly in the antero-posterior position, the limb must be placed in a position of internal rotation.

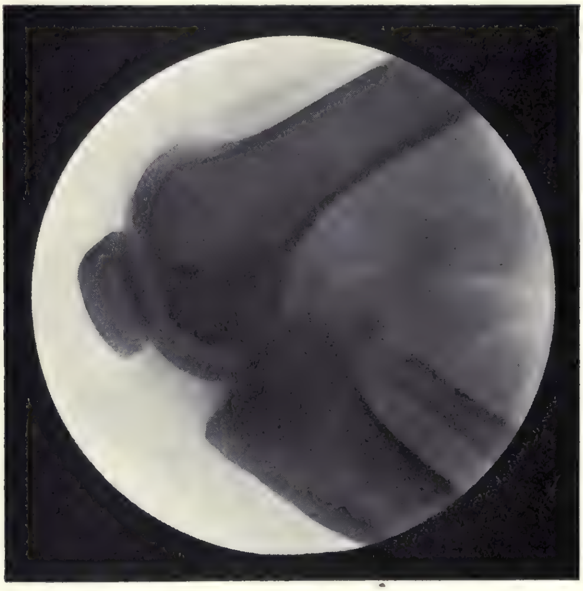

Fig. 24.

Lateral view.—Two different lateral views are possible. One with the internal aspect of the joint in contact with the plate. This is usually a difficult position to get the patient into. The best plan is to have a little wooden bridge or table made with four legs about six or seven inches

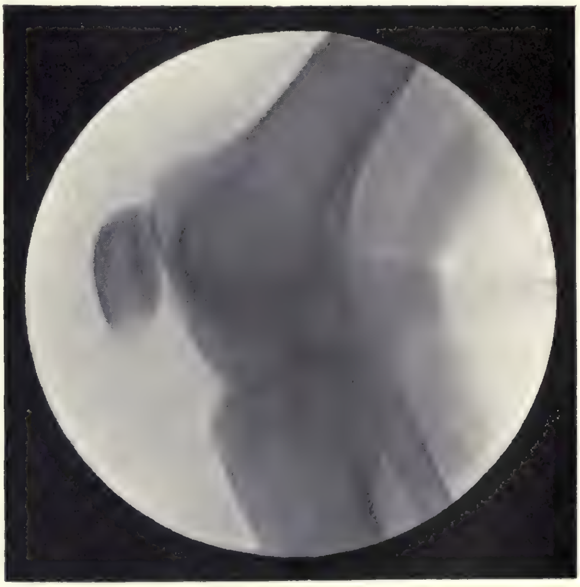

Fig. 25.

high. The sound limb goes under this bridge, while the affected limb lies on a plate, on the top of the bridge. In the absence of such bridge the patient may be made to hold the plate between the knees. The other lateral view with the external aspect of the joint in contact with the plate is more convenient, and the patient will be able to lie more steadily in this position.

Any degree of flexion may be chosen as the "normal position," but the knee at a right angle can always be reproduced. In cases of disease or injury of the joint, this position is nearly always attainable.

As regards the focus-point, the lower pole of the patella is not an accurate guide, as this bone alters its position in relationship to the line of the joint in various degrees of flexion. (Figs. 23, 24, 25.) The line of the joint can nearly always be felt, and the "normal" focus-point is therefore chosen in the line of the joint.

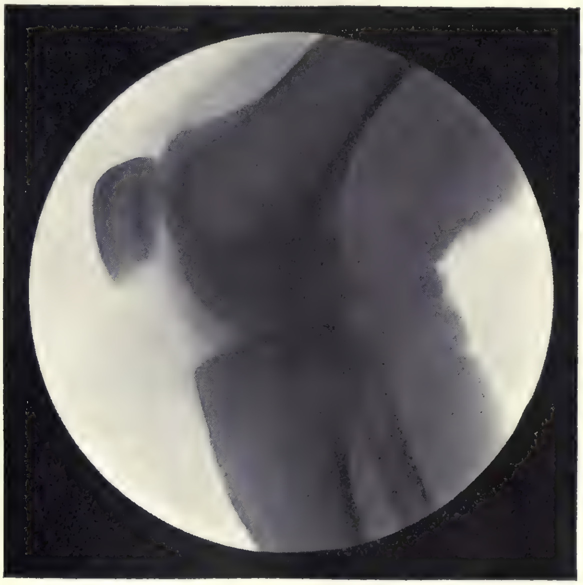

Fig. 26.

The internal condyle of the femur is anatomically on a lower level than the external condyle. Its shadow on an X-ray plate is therefore at a lower level than the external. So great is the difference in level between these two condyles that it does not matter where the focus-point is chosen (within limits), the shadow of the internal condyle is always the lower. Compare Fig. 26 taken with focus-point four inches above the level of the joint with another plate taken with focus-point four inches below the level of the joint. The internal condyle in either case is at the lower level.

The obliquity of the long axis of the articular portion of the upper end of the tibia has already been referred to in dealing with the antero-posterior view. The effect of this is well marked in the lateral view. The internal condyle of the femur, and likewise the inner tuberosity of the tibia, lying in a plane posterior to that of the external condyle and tuberosity, their shadows are always seen behind those of the external.

During flexion of the joint a certain amount of rotation occurs, and in full flexion (Fig. 24) the extent of rotation is sufficient to make the shadow of one condyle nearly coincide with the shadow of the other condyle. This same coincidence of shadows is seen when the radiograph has been taken four inches posterior to the middle of the joint.

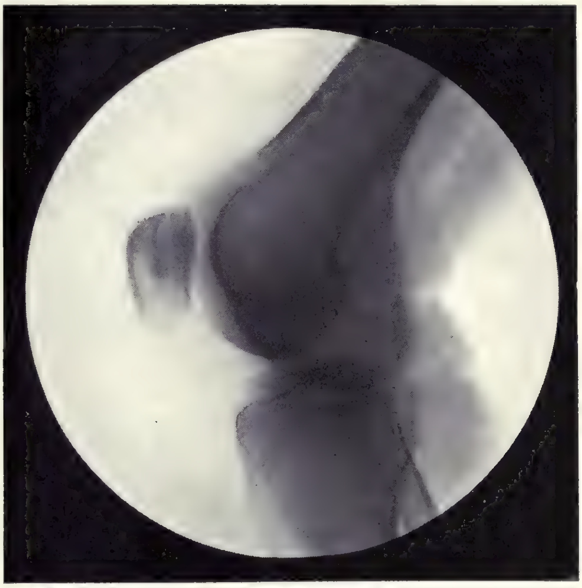

Fig. 27.

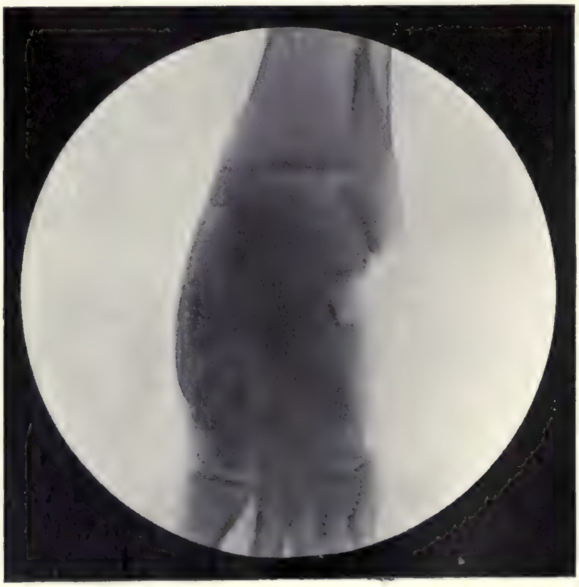

Fig. 28.

When the focus-point is chosen four inches in front of the joint, as in Fig. 27, the shadow of the internal condyle is thrown further behind that of the external than in the normal.

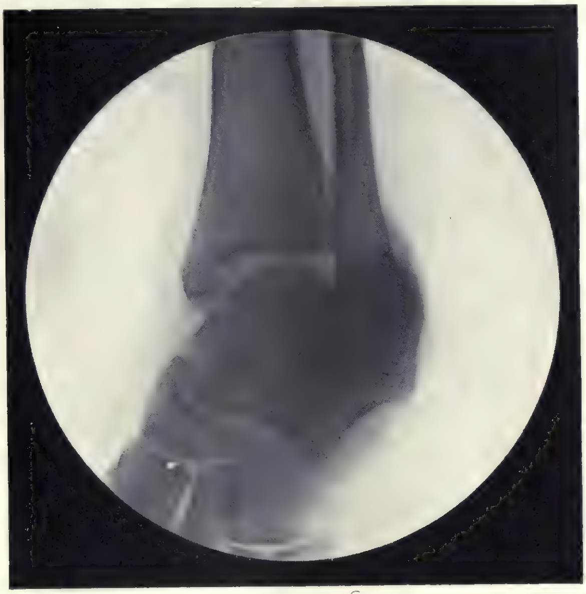

Fig. 29.

In this view (Fig. 27) it should be noted that there is an apparent break in the continuity on the edge of the external condyle of the femur at the level of the lower pole of the patella. This has often been diagnosed as erosion of cartilage where particular attention has not been paid to the choice of focus-point. This apparent break is seen in radiographs which are taken even a

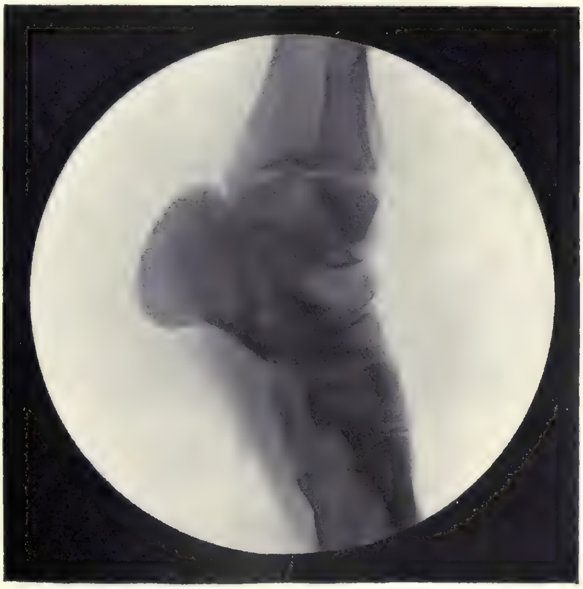

Fig. 30.

very small distance in front of the joint. It is due to the overlapping of a portion of the shadow of a part of the non-articular portion of the lower end of the femur. In certain positions of the limb, the shadows of the two semilunar cartilages are so approximated that the projecting outer edge of the one appears to spring out of the other. Care must be taken lest this is diagnosed as fracture of a semilunar cartilage.

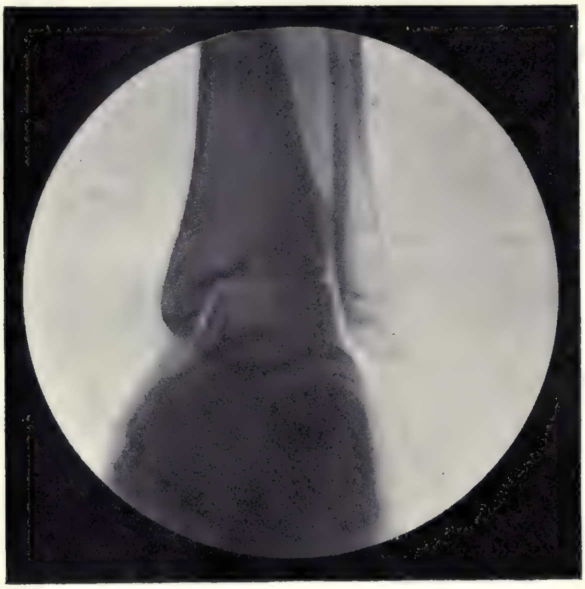

FIG. 31.

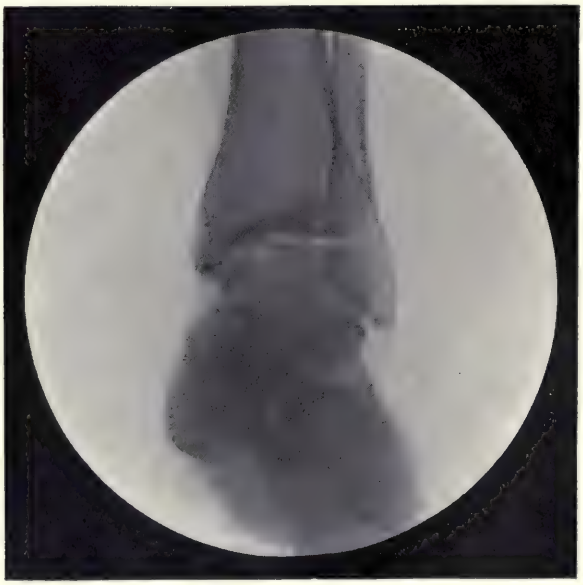

FIG. 32.

ANKLE JOINT AND TARSUS.—It is convenient to take these together, as the same focus-point and same positions do in both cases.

The joint itself may be looked upon as a simple hinge joint, with limited movement. It should be noted that here, as in the knee, the fibula is in a plane posterior to that of the tibia. Notwithstanding its limited range of movement, the degree of flexion and extension markedly alters the radiographic appearance in the antero-posterior view. In the lateral view an alteration in the position does not make much difference.

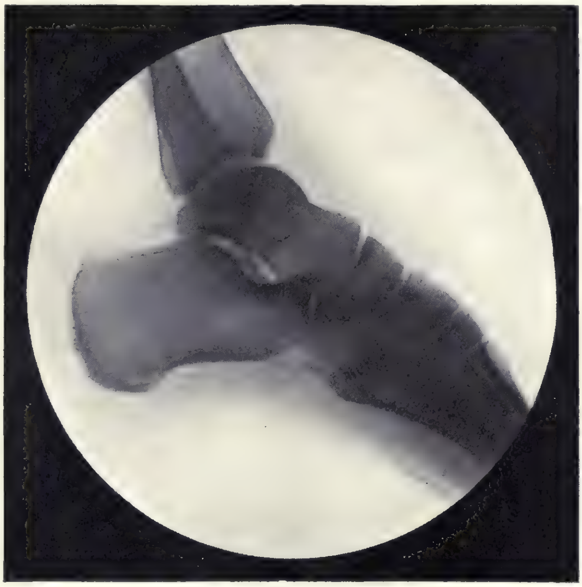

FIG. 33.

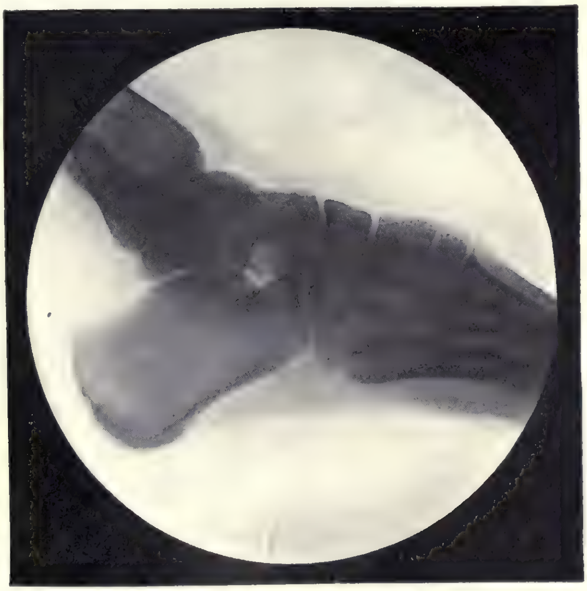

FIG. 34.

Antero-posterior view.—In the antero-posterior view the foot should be nearly at right angles to the leg. If the toes are pointed the shadow of the os calcis obscures the joint. The normal position of choice, therefore, is in the above position.

Fig. 28 is taken from the normal focus-point, viz., over the centre of the joint. The foot here has been in a position of extreme plantar flexion. (Toes pointed.) Note how the joint is obscured by the combined shadows of the astragalus and os calcis. Note also the overlapping of the tibia and fibula.

Fig. 29 is taken with the toes still pointed, but the foot in a position of slight internal rotation. The same foot has been radiographed throughout this series, and is perfectly normal. This view, however, would lead anyone who did not know the position of the limb at the time of exposure to believe that the foot had been subjected to no small degree of violence.

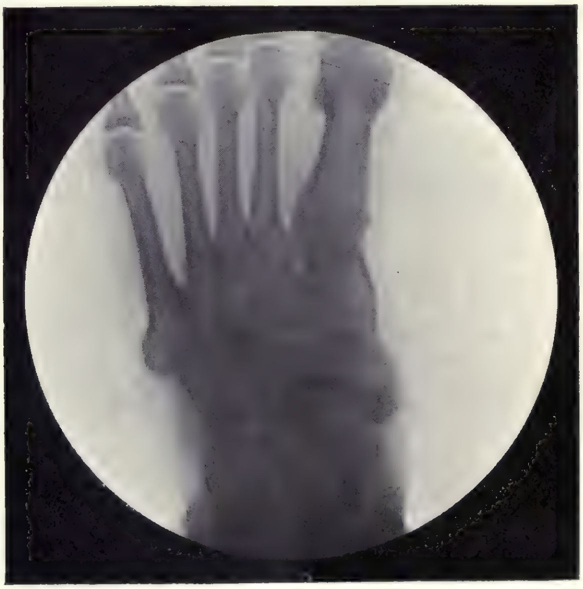

Fig. 35.

Fig. 30 is taken with toes pointed, but with foot in position of slight external rotation.

Figs. 31 and 32 have been taken with the foot at right angles to the leg. The position of the limb has been respectively (31) slight internal rotation, and (32) slight external rotation. It will be noticed that, as the limb is rotated inwards, a better view is obtained of the inferior tibio-fibular articulation.

Lateral view.—It makes almost no difference whether the inner or the outer aspect of the foot is in contact with the plate. As it is the easier position, the normal has been chosen with the outer aspect of the foot in contact with the plate. The normal focus-point has been chosen as directly above the internal malleolus, for as this is the usual focus-point in the ankle it may be taken as the normal for the tarsus.

In the normal view the ankle joint and tarsal bones are seen in a general way at their best. Any alteration in the focus-point makes little or no difference. Fig. 33 is taken in the normal position, and from the normal focus-point. Little difference will be detected on comparing this view with a plate taken with F.P. four inches towards the heel, or another taken with F.P. four inches towards toes, or with Fig. 34, F.P. four inches below. This last picture, however, shows the cuboid better than any of the others.

Plantar view of foot.—Fig. 35 is taken with the sole of the foot on the plate, and the focus-point at the tarso-metatarsal joint. It is impossible to show in any radiograph of an adult foot the individual cuneform bones clearly, because they are, as the name implies, wedge shaped, and the pointed ends of the wedges are directed towards the sole of the foot. The shadow of the base of the metatarsal of the great toe always overlaps the shadow of the internal cuneform. This overlapping must not be diagnosed as a fracture. The space between the internal and middle cuneform bones varies slightly with the choice of focus-point.

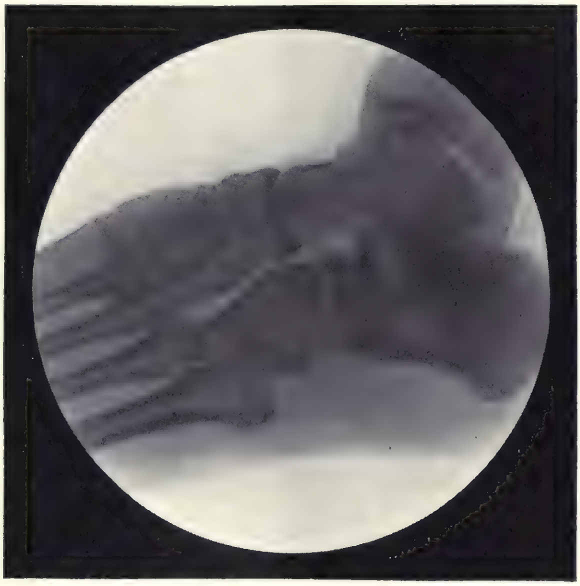

FIG. 36.

Semilateral view of foot.—Fig. 36 is a convenient view in many cases. It shows the two rows of tarsal bones apart from one another, viz., os calcis, cuboid, and two metatarsals, (2) astragalus, scaphoid, three cuneforms, and three metatarsals. This is the only view which gives the complete view of the cuboid. The focus-point is over the medio-tarsal joint, and the position of the foot is as follows :—The inner aspect of the foot in contact with the plate. The upper part of the calf of the leg is lying supported by the other foot.

A SKETCH OF THE HISTORY OF ELECTROTHERAPY.

By Hector A. Colwell, M.B., D.P.H.

I.

If we limit the term electrotherapy to the treatment of disease by scientifically standardized electrical apparatus, its history is clearly a very short one; if, on the other hand, we consent to include under that term the employment of remedial agents, whose real or supposed efficiency depends upon electrical phenomena, it can claim an antiquity as great as any branch of medical science. Needless to say, in this latter case the data are few, the diagnoses of the same value as those in most other branches of medicine of equal antiquity, while the apparatus was derived not from the laboratory of man, but of Nature.

The use of medicinal springs dates, of course, from time immemorial, and if in some cases these derive a part, at any rate, of their efficacy from the presence of radio-active substances, we are faced with the paradox that not only electrotherapy, but radiotherapy itself, must rank among the remedial measures of antiquity, and was employed centuries before the term electricity was ever heard of. Equally curious at first sight is the fact that the first source of static electricity employed in the treatment of disease was a living animal, the torpedo, an elasmobranch fish of the ray family, common in the Mediterranean and in tropical seas. From the earliest times the inhabitants of these coasts have been accustomed to bathe their children in water in which one of these fishes was placed; nor are classical writers silent about the value of its shocks in cases of paralysis, cramp, painful affections of the joints, and various disorders commonly regarded as being of nervous origin. Anthero, a freedman of the Emperor Tiberius, was reported to have been cured of the gout by placing his foot upon a live torpedo by the seashore. Dioscorides recommended the shocks of the torpedo as a remedy for intractable headaches, a prescription in which he was followed by Galen. Pliny, in his "Natural History," refers to the torpedo in terms which imply that it was well known as a therapeutic agent, thus—"From a considerable distance, even, and if only touched with the end of a spear or staff, this fish has the property of benumbing even the most vigorous arm, and of riveting the feet of the runner, however swift he may be in the race. If, upon considering this fresh illustration, we find ourselves compelled to admit that there is in existence a certain power, which by the very exhalations, and, as it were, emanations therefrom, is enabled to affect the members of the human body, what are we not to hope for from the remedial influences which Nature has centred in all animated beings?"

According to Coldstream, who contributed an article on Animal Electricity to Todd's "Cyclopædia of Anatomy and Physiology" (1836-1839), the torpedo was still employed among the Arabians at that time. In this case, however, the *modus operandi* was somewhat modified, the patient being placed naked upon a table while the fish was applied to different parts of the body in succession; this author adds that, "This treatment causes rather severe suffering, but enjoys the reputation of being febrifuge."

The true character of the shocks given by the torpedo was not elucidated till 1772, when Dr. John Walsh published the results of his observations, and proved them to be identical in character with those obtained from an ordinary electrical machine. In the same year John Hunter dissected the fish, and described the anatomy of its electrical organ, while in 1773 Ingenhousz, of Vienna, independently made observations similar to those of Walsh, and arrived at the same conclusion. Previously to these observers, the illustrious Italian, Francesco Redi, had in 1666 obtained specimens of the torpedo, and experienced their shocks, while he was, moreover, the first to dissect them, and to furnish a brief description of the electrical organ. Réaumur also described the shocks, which he erroneously ascribed to sudden muscular action. Kaempfer, in 1712, compared the sudden stroke of the torpedo to lightning, but inaccurately added that by holding the breath the observer was prevented from feeling the shock.

For purposes of completeness, we may add a brief account of some of the early observations upon the *Gymnotus electricus*, or electric eel of South America. So far, however, from its being employed by the natives as a therapeutic agent, it was regarded by them with terror. The earliest European accounts of this fish seem to have been those of de la Condamine, who noticed its extraordinary powers, and described it under the title of "un espèce de lamproi." Far more extensive were the observations of Bancroft in his "Natural History of Guiana" (1769); he furnishes a good description of the creature, compares its shock to that of electricity, and proposes the name of "Torporific Eel." Humboldt and Bonpland, during their travels in Guiana in 1800, were desirous of obtaining specimens, and furnish a vivid description of the difficulties attending their capture. The natives had such a terror of the Gymnoti, that for a long time they could not be persuaded to make any attempt. Eventually they procured about thirty horses, and by driving them into the pond containing the fish the unfortunate horses received the shocks from the eels, which were then captured in a state of exhaustion. Some idea of the force of the shocks may be gathered from the fact that in less than five minutes two horses were drowned, while all exhibited signs of terror and agony.

Communications in which the electrical nature of the discharge was established were made in 1775, by Dr. Garden, of Charlestown, while dissections were again undertaken by John Hunter.

As another form of primitive electrotherapy may be mentioned the use of the lodestone in the treatment of disease. There is, however, an obvious difference between the employment of such a source of natural electricity as the torpedo, which, whatever the merits or demerits of the proceeding may have been, at any rate administered a genuine electric shock, and the therapeutic use of the natural magnet or lodestone. In this latter case there was no shock, and there could have been no effect from its action, except either a psychological effect, or one due to its chemical properties as a compound of iron. Indeed, the employment of the lodestone in medicine really comes under the heading of what is known to anthropologists as sympathetic magic. The obvious characteristic possessed by the mineral in question, of attracting iron, was held to indicate the possession of powers of attracting or repelling the causes of disease; superstitions concerning them were, as may be imagined, extremely common, while accurate observations were reduced to a minimum. Pliny records that iron could be magnetized by the lodestone, and adds that wounds inflicted by a weapon so treated were particularly severe. Lodestones triturated and calcined were employed in ophthalmic preparations, and as an application for burns. The ancients cherished an absurd superstition, again recorded by Pliny, to the effect that natural magnets were of different sexes, "The leading distinction is the sex, male and female, and the next great difference in them is the colour. One found in Troas is black, of the female sex, and consequently destitute of attractive power." The most highly esteemed variety was the Ethiopian which was purchased for its weight in silver. These extraordinary assertions regarding natural magnets did not decrease during the middle ages, and

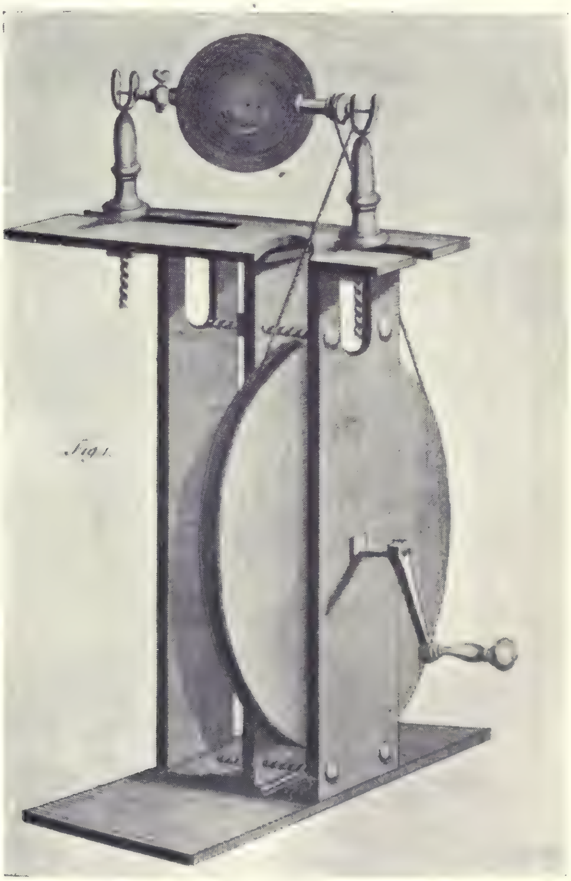

Fig. 1.—Hauksbee's Electric Machine. (From Priestley's "History of Electricity," 3rd Ed., 1775.)

according to a recent writer, Dr. Fernie, there is still a considerable sale of small pieces of magnetic iron oxide for use as amulets. Among other virtues the lodestone was recommended for cramp and gout, and was reputed to be efficacious in reconciling estranged husbands and wives. As an example of the nonsense which could be written by a learned man about the magnet, may be quoted an extract from van Helmont (1557-1624). Van Helmont was an alchemist; in many ways he was a shrewd observer, but it would be difficult to find passages in which real and imaginary phenomena are more confused than the following. "The back of the lodestone, as it repulseth iron; so also it drives back the Gout, cures Burstness and every catarrh or rheum which is of the nature of iron." Again, according to the same writer, the power of the lodestone is lost if it be rubbed with garlic, a statement which one would have thought could have been verified or refuted without the expenditure of an abnormal amount of experimental ingenuity.

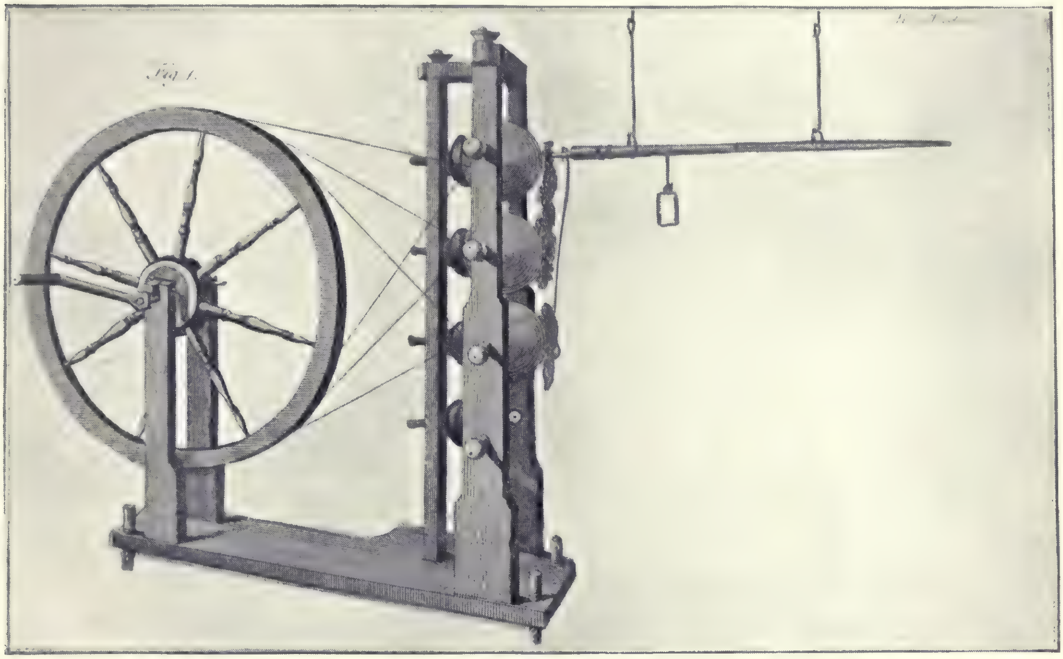

Fig. 2.—Dr. Watson's machine, constructed for four globes, three of which are shown in position. The conductor is seen on the right, suspended by silk cords; the rubbers are on the immediate left of the globes. (From Priestley's "History of Electricity," 3rd Ed., 1775.)

It was not likely that any progress could be made in physics while such inextricable confusion of ideas prevailed, and the first beginnings of the modern science of electricity are due to William Gilbert (1540-1603) President of the Royal College of Physicians, and Physician to Queen Elizabeth, and afterwards to James I., although he died in the year of the latter monarch's accession. It is a curious instance of the irony of fate that one of the most pedantic buffoons who ever occupied a throne should have had his court honoured with the presence of two of the founders of modern experimental science—Francis Bacon and William Gilbert. In the year 1600, Gilbert published his work, "*De Magnete*," which laid the foundation of modern conceptions of electricity. He was the first to show that other bodies besides amber and jet could be electrified by friction, while the term "electric" was first used by him in the treatise in question. Queen Elizabeth took a keen interest in Gilbert's work, and granted him a pension; and, indeed, he seems to have had the good fortune, only too rare with pioneers of science, to have been appreciated at his true value during his lifetime. He bequeathed his books and scientific apparatus to the Royal College of Physicians; unfortunately, however, they were destroyed in the Great Fire of 1666.

While the apparatus at the disposal of electricians consisted solely of small fragments of amber and sulphur, which attracted light bodies when rubbed, it was clearly impossible for any save the most elementary truths to be established, and the next great step in electrical knowledge was the making of a primitive electrical machine by Otto von Guericke about the year 1650. His "machine" consisted merely of a globe of sulphur, furnished with an axis and mounted in a frame, while the application of his own hand supplied the necessary friction. With this crude machine he was able to see the electric spark, and to observe the curious crackling sound which accompanies it. Much better sparks, however, were obtained later by Dr. Wall, who employed a rod of amber rubbed by a woollen cloth, and at the same time noted that "this light and crackling seem in some degree to represent thunder and lightning." Their identity was, of course, not established till 1749, by Benjamin Franklin.

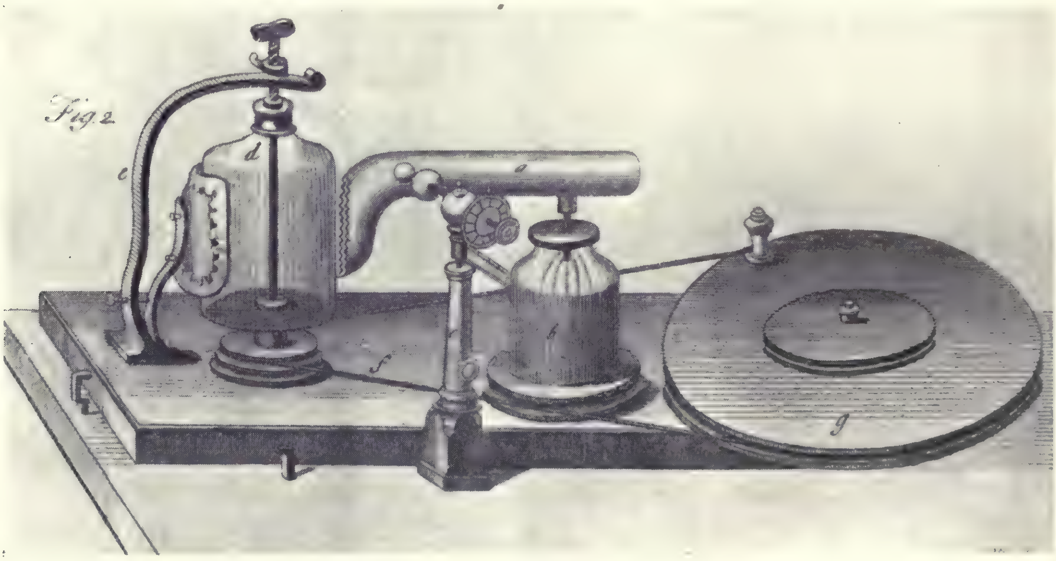

FIG. 3.—Read's cylinder machine, specially constructed for medical purposes. (*a*) The conductor, connected with the coated jar (*b*); (*c*) is a Lane's electrometer, (*d*) the cylinder. (From Priestley's "History of Electricity," 3rd Ed., 1775.)

Hauksbee, in 1709, substituted a glass globe for von Guericke's globe of sulphur, although, as a matter of fact, the original sulphur globe was cast inside a glass vessel, which was subsequently broken. After a comparatively short time these electrical machines, in both of which the hand was used as the rubber, were discarded in favour of rods of amber, glass, sulphur, and sealing wax. The introduction of a rubber as part of the apparatus was due to Giessing, a co-worker with Winckler, of Leipzig, while for the first conception of a prime conductor we are indebted to Bose, who employed an iron tube held by an assistant standing upon cakes of resin. Subsequently the tube was suspended by silk threads, either from the ceiling or from some suitable framework.

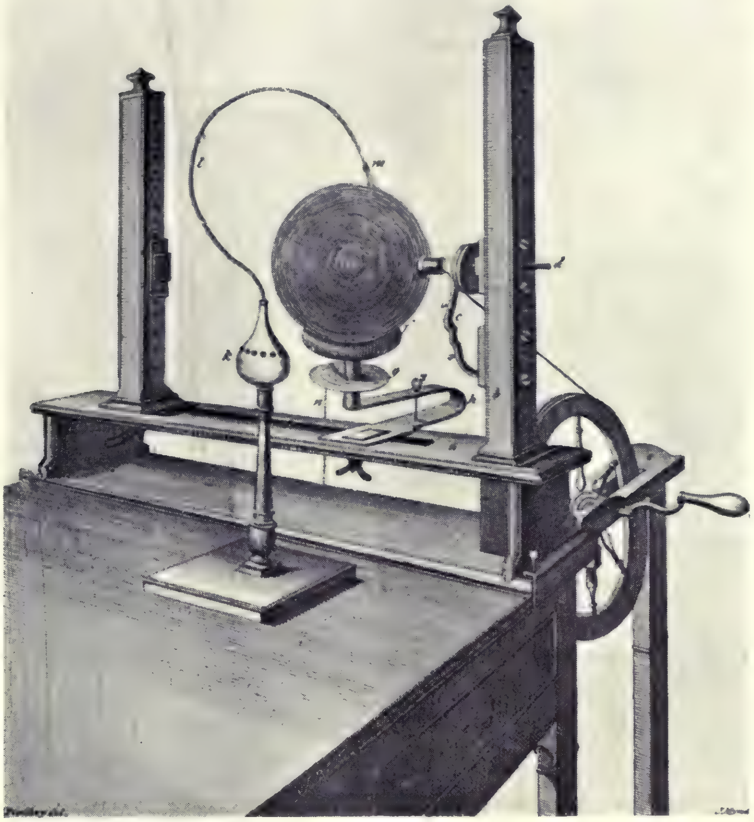

Fig. 4.—Priestley's own machine, fitted with adjustable supports for globe and rubber. The conductor (*k*) collects the electricity by the flexible wire (*l*), and is furnished with a series of perforations to allow of the introduction of wires for experimental purposes. (From Priestley's "History of Electricity," 3rd Ed., 1775.)

The essential parts of a frictional electric machine having been thus evolved, investigators, especially in Germany, sought to obtain an increased electrical discharge by multiplying the number of globes which could be rotated in one machine. Such a machine, constructed to work four globes, is shown in Fig. 2. The globes were commonly detachable from the machine, so that their number could be varied at will. The substitution of glass cylinders for globes was due to a Scotch Benedictine named Gordon, who was Professor of Philosophy at Erfurt; an early cylinder machine, specially designed for medical purposes, is shown in Fig. 3, while a machine built to the specification of the celebrated Priestley is shown in Fig. 4. These figures are taken from Priestley's work on the "History of Electricity" (2nd ed., London, 1775), a book which well deserves reading, not only because of the interest of its subject matter but also on account of its charm of style.

The Leyden Jar, which plays an important part in some of the early experiments in electrotherapeutics, was discovered by von Kleist, Dean of the Cathedral of Camin, in 1745. An apparently independent discovery of the same kind was made by Cuneus and Muschenbroeck at Leyden in 1746, and although the priority unquestionably belongs to von Kleist, the piece of apparatus became known as the Leyden Jar. It is of interest to read the records of some of the early experiments on the action of electricity upon the human subject, since we are able to repeat them ourselves, and to compare our own observations with the accounts given by the early observers. Thus Muschenbroeck, in communicating to Réaumur the account of the shock he received from his very primitive Leyden Jar, states that he felt himself struck in the arms, shoulder and breast; he lost his breath, and it was two days before he recovered from the shock and fright. He added that not for the Crown of France itself would he expose himself to such another experience.

The most extravagant description of the effects of a shock from a Leyden Jar is that of Winckler, which is given by Priestley thus: "The first time he tried the Leyden experiment, he found great convulsions by it in his body; and that it put his blood into great agitation, so that he was afraid of an ardent fever and was obliged to use refrigerant medicines. He also felt an heaviness in his head, as if a stone lay on it. Twice, he says, it gave him bleeding at the nose."

As regards the earliest experiments upon the effects of electricity on the human subject. it is clearly difficult to assign definite priority, since the first rubber for the sulphur or glass globe was the operator's own hand. In 1730 Stephen Gray suspended a small boy by hair cords, and on bringing a charged tube near his feet found that the lad's head attracted scraps of copper leaf, thus demonstrating the phenomenon of electrification by induction. The first to draw sparks from an electrified human being was Du Fay, a physician, and superintendent of the royal gardens in Paris. Du Fay caused himself to be suspended by silken ropes, and while in this situation to be electrified. Upon the approach of the hand of another person sparks were observed, to the surprise of both Du Fay himself and of the Abbé Nollet, who was also present

The first recorded observation of the use of electricity for a specifically medical purpose is that of Kratzenstein, Professor of Medicine at Halle, the patient being a woman who suffered from a contraction of the little finger; after a quarter of an hour's electrification the condition was reported as cured. Whatever the permanent effect on the finger may have been, Kratzenstein also noted the acceleration of the pulse-rate as a sequel to electrification.

Jallabert, of Geneva, in 1747, effected an improvement in a locksmith, whose arm had been paralysed for fifteen years, the exciting cause of the disorder being recorded as a blow from a hammer. The arm was treated both by drawing sparks from it, when the individual was electrified, and by the application of the electric shock. The beneficial effect was, however, merely temporary, and the patient relapsed into his original condition.

The years 1747 and 1748 are interesting in the history of electrotherapy from some extraordinary claims which originated in Italy, and were reported to be confirmed in Germany. That they were deliberate cases of fraud one is unwilling to believe; though by what process of self-delusion the observers arrived at their conclusions it is difficult to understand. In this connection, however, it may be well to bear in mind the early records of the effects of a shock from a Leyden Jar.

The ball was set rolling by Pivati, of Venice, Keeper of the Library, and member of the Academy of Bologna. It may be well here to examine the chain of reasoning which Pivati followed in his experiments. In the first place, he was acquainted with the fact that electrification of an individual accelerates his pulse-rate; from this he concluded that the subtle electric fluid could penetrate the whole human body, even reaching to the heart. He next turned his attention to the electrification of all kinds of natural objects, minerals, fossils (at that time a rife source of wonder and speculation), and to flowers. On electrifying a vase of flowers, and allowing a spark from the electrified system to enter his nostril, he observed both the odour of the flower and a peculiar "nitrous smell." That he should smell a perfumed flower placed close to his nose is not surprising, while the smell of the ozone accompanying an electrical discharge was very fairly described as "nitrous." Pivati, however, imagined that the perfume of the flower was carried by the electrical discharge to his nose, and that since the electric fluid could penetrate all parts of the body, as shown by its action on the heart, it would carry volatile substances along with it, and thus serve as a means of administering drugs without the usual preliminaries of tasting and swallowing them.

So far, the line of thought is fairly clear and coherent. Pivati's next step was to enclose some Balsam of Peru in a glass cylinder, which he alleged to be hermetically sealed, and to emit no odour even when warmed. Upon electrifying the cylinder by friction the case was different, and the odour of Balsam of Peru was declared to pervade the room. A man who suffered from a pain in the side was electrified by this prepared and sealed cylinder, he himself being ignorant of the nature of its contents. The recorded result of this treatment is, to say the least of it, surprising. The patient went home, fell asleep, broke into a profuse perspiration, and his clothing and bedding all exhaled the odour of Peruvian Balsam; in order that nothing might be wanting to carry conviction to the most sceptical, it was recorded that the comb he had used was similarly perfumed.

On the following day Pivati electrified a normal individual with the same tube, the subject being again ignorant of its contents. The recorded result was, that about half an hour afterwards he felt a gradual warmth pervading his body, he became unusually lively, and exhaled the odour of Balsam of Peru.

Pivati had a more distinguished patient, the Bishop of Sebenico. This poor old gentleman was so afflicted with gout that he was unable to move either his hands or his knees. After two minutes' treatment he opened and shut his hands, shook hands with his attendants, and walked downstairs like a young man!

Winckler (already mentioned as the hero of a Leyden Jar experiment) also performed some experiments upon similar lines. In one of these he introduced sulphur into a glass sphere, which was then carefully sealed, so that upon heating no odour of sulphur was perceptible. Upon electrifying the cold sphere, he recorded that a strong smell of sulphur pervaded the room, and on continuing the electrification the smell became so intolerable that the bystanders were compelled to withdraw. Winckler relates that he himself remained, and that his body, clothes, and breath smelt of sulphur all the next day. On repeating the experiment, the "signs of an inflamed blood were visible in his mouth on the third day."

Bianchi,* Professor of Medicine at Turin, also claimed to have observed that purgatives, such as scammony, held in the hand of a person during electrification, produced the same effects as when administered by the mouth, and similar results were claimed by Veratti, of Bologna.

These extraordinary claims were investigated by the Abbé Nollet, who journeyed to Italy for the purpose. After visiting the various experimenters, he came to the conclusion that there had been gross exaggeration in the accounts of their cures, and in no single instance was he able to substantiate the permeability of glass to volatile substances under electrification.

Winckler sent an account of his results to the Royal Society. The experiments were repeated, but without success. The Royal Society accordingly requested him to send over some of his own apparatus, which he forthwith did. On the twelfth of June, 1751, a Committee of the Society met at Dr. Watson's house, and again repeated the experiments with Winckler's own apparatus, but here again complete failure resulted.

Owing to the limited character of the electrical appliances then available, the legitimate electrotherapy of the eighteenth century was confined to either insulating the patient, electrifying him, and then drawing sparks from the affected part, or to the administration of shocks, usually by means of one or more Leyden Jars.

Among the early workers in this field, two are of especial interest—John Wesley and Benjamin Franklin. Wesley, as is well known, was fond of dabbling in medicine, and seems to have acted as a kind of medical adviser to the members of his congregation. Priestley, in his "History of Electricity," says, "Mr. Wesley's people, I believe, generally use a machine in which two cylinders are turned by the same wheel; but one that I saw, in the possession of a very intelligent member of that persuasion, had the cylinders and rubbers so confined in a chest, that, though it might do very well for medical uses, it was very ill adapted to the purposes of philosophy." Priestley, however, had a high opinion of Wesley's electrotherapeutic measures, as the following passage bears witness: "The Rev. Mr. J. Wesley has followed Mr. Lovet in the same useful course of medical electricity, and recommends the use of it to his numerous followers and to all people. Happy it is when an ascendency over the minds of men is employed to purposes favourable to the increase of knowledge, and to the best interests of mankind."

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* In view of certain similarities between the names, the work of Bianchi must be clearly distinguished from that of Bianchini and of Bianconi, Physician to the Prince of Aosta. Both these observers repeated the experiments of Pivati, and were totally unable to corroborate them.

Franklin records his observations in a letter dated December, 1757, and addressed to Sir John Pringle, by whom it was communicated to the Royal Society. After referring to the fact that the newspapers contain accounts of great cures performed in Italy and Germany, he proceeds to an account of some of his own cases. "People were brought to me from different parts of Pennsylvania and the neighbouring provinces to be electrified; which I did for them at their request. My method was to place the patient first in a chair, on an electric stool, and draw a number of large sparks from all parts of the affected limb or side. Then I fully charged six two-gallon jars, each of which had about three square feet of surface coated; and I sent the united shock through the affected limb or limbs; repeating the stroke commonly three times each day." At first some improvement was noted, but Franklin records that he never saw any improvement after the fifth day, a fact which was also noted by the patients themselves, who, either through disappointment or from the unpleasant severity of the shocks, usually returned home and did not apply for further treatment. Franklin's letter, as may be imagined from his general character, is a model of candour, and stands in marked contrast to the exaggerated statements of Pivati, Winckler, Bianchi, and certain other workers about this time. He freely admits that he doubts whether the temporary improvements were due to his treatment, or to the exercise necessitated by the walk to his house, and adds that he wishes the advice of a skilled physician could have been obtained to direct the treatment, administer suitable medicines, and attend to the patients' general condition.

The Abbé Nollet also admits that during an experience of fifteen or sixteen years he had not known of a permanent cure from electrification, though he adds that he had also not noticed any ill effect.

(To be continued.)

RADIOGRAPHY IN GUN-SHOT WOUNDS OF THE SKULL.

By George Vilvandré, Capt. R.A.M.C.,
Radiologist No. 16 General Hospital. B.E.F.

Head wounds in which the cranium is involved may be divided into two classes : those in which the foreign body penetrates the skull and *lodges* in the brain, and the second in which the foreign body damages only the outer or inner table, but either glances off the bone or perforates the skull from side to side, the outlook being darkened in proportion to the damage done by the missile in its tract.

From the many cases one has seen, the prognosis must be worse when the foreign body lodges in the brain. Firstly, because of the sepsis entailed and its sequelæ of deep-seated abscess ; secondly, because of the irritating presence of the missile ; and thirdly, because of the trauma necessarily caused by the surgeon in his search for its removal ; besides the primary disintegration of nerve cells and fibres in its path.

The undertaking of the operation of trephining should not be lightly done, and only the experienced surgeon has a right to do so. Much more care and skill are required when the opening of the dura is necessary, and here I would emphasise the point that, within reach of an X-ray apparatus and competent radiographer, no operation should take place on a skull which has not been previously radiographed to ascertain the presence or absence of a foreign body, and its careful localization.

To trephine a skull for a depressed fracture, the clinical signs of which are obvious or even urgent, without first ascertaining the presence or absence of a missile (again where the case is within reasonable reach of the X rays) does not seem to be rational. The relief of decompression may be sought and had within a few hours ; but if the patient still has a bullet or piece of shrapnel in his brain, is the future prognosis really improved ? I think not, and even if I were to I maintain that the patient should be radiographed first so as to avoid a second operation.

We must recognise the seriousness of trephining in war surgery. To my mind it is often like opening the portals of death. Therefore to have to re-open a skull for the removal of the missile is courting death a second time.

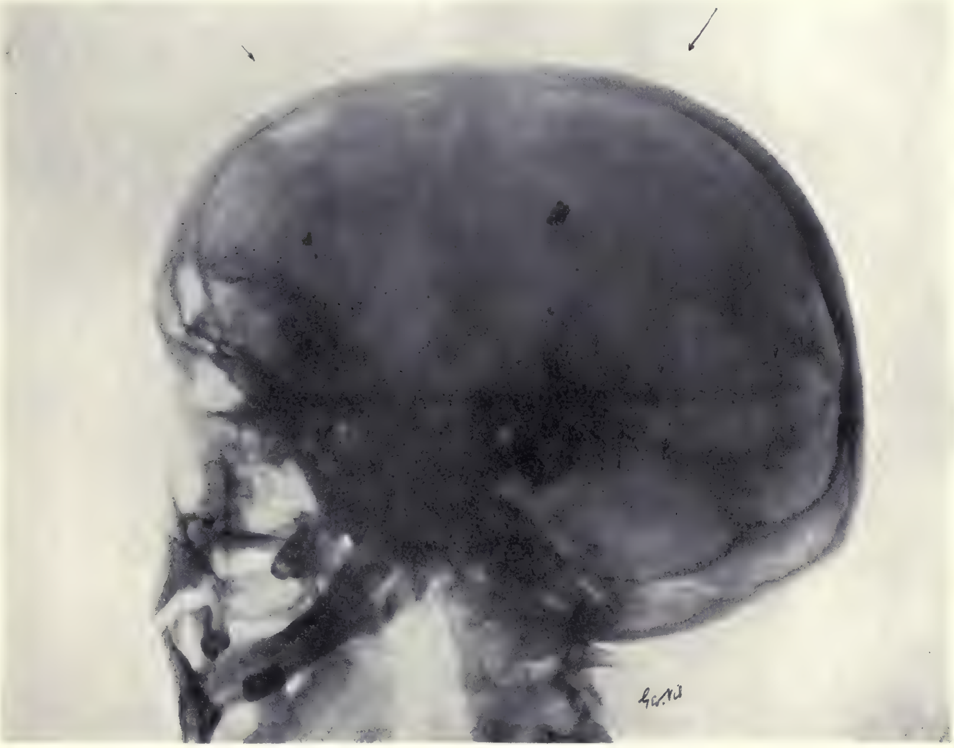
We must come to the conclusion that in all cases—with perhaps a few remote exceptions—a patient with a bullet or shrapnel in his brain will within some six months die of cerebral abscess. This teaching is certainly most emphatic on this side of the Channel, and I have it on eminent authority. The only exception which might be allowed is that in which the bullet is not distorted through a previous ricochet and in all probability aseptic. The first point may be ascertained by X rays. Who will swear to the second ?

Further, owing to the softness of brain matter (especially when damaged) bullets, because of their weight, travel in the brain, and their path must mean further damage.

Since writing the above, the following case arrived. (No 1.) This patient (Case 310^3) was previously trephined at a field hospital before admission to No. 16 General Hospital, where he was X-rayed and found to have a trephined hole in the frontal bone, a linear crack posterior to the petrous bone, and a depressed fracture with shrapnel and bony fragments. These were located at a depth of 1½ in. and removed by Lieut. T. Twistington Higgins, F.R.C.S.

This is an instance of a case trephined for the purpose of decompression, which had to undergo a second operation for the removal of a foreign body and bony fragments in the brain.

Would not lumbar puncture (Percy Sergent and Gordon Holmes) to allay the compression symptoms, performed at the field or the clearing hospital, have been preferable to operating on a skull, the condition of which was very imperfectly known?—probably for the want of the necessary X-ray plant and operator.



CASE NO. 1.

Whilst fully convinced of the importance of radiography previous to operation in skull cases, one must not forget that even a good radiogram may be negative when the clinical symptoms point to the presence of a depressed fracture—which may be small or at the base. This apparent failure of the X rays is still more obvious in the presence of a small linear crack or fissure, although I have often been able to show this. Although the small fracture may escape detection radiographically the presence or absence of a foreign body will always be determined, and the clinical signs should outweigh a negative radiogram in the guidance of the surgeon.

Furthermore, as a rule the damage to the skull is more extensive than shown on the radiograph ; this being probably due to the incidence of the rays on a round body. A straight pencil of rays will tend to convert a cylindrical object into an elliptical image if striking that cylinder laterally, and the ellipse will vary with the angle of incidence.

So much for the hawking of my ware. I may, in what follows, be jumping to too early conclusions, but I have been forcibly impressed in the operating theatre and in the wards, following many head cases previously radiographed, by the fact that skulls with long comminuted fractures and *no* foreign body being present, skulls in which even depression was great, seemed to do well. Such a case is that of Capt. Nash-Wortham's, which I have asked him to publish. To put it briefly :—in spite of the great damage done to the vault, the extensive comminution, the depression of the fragments and ablation of bone, this man did well, and went home to England smoking and happy. (Case No. 2.)

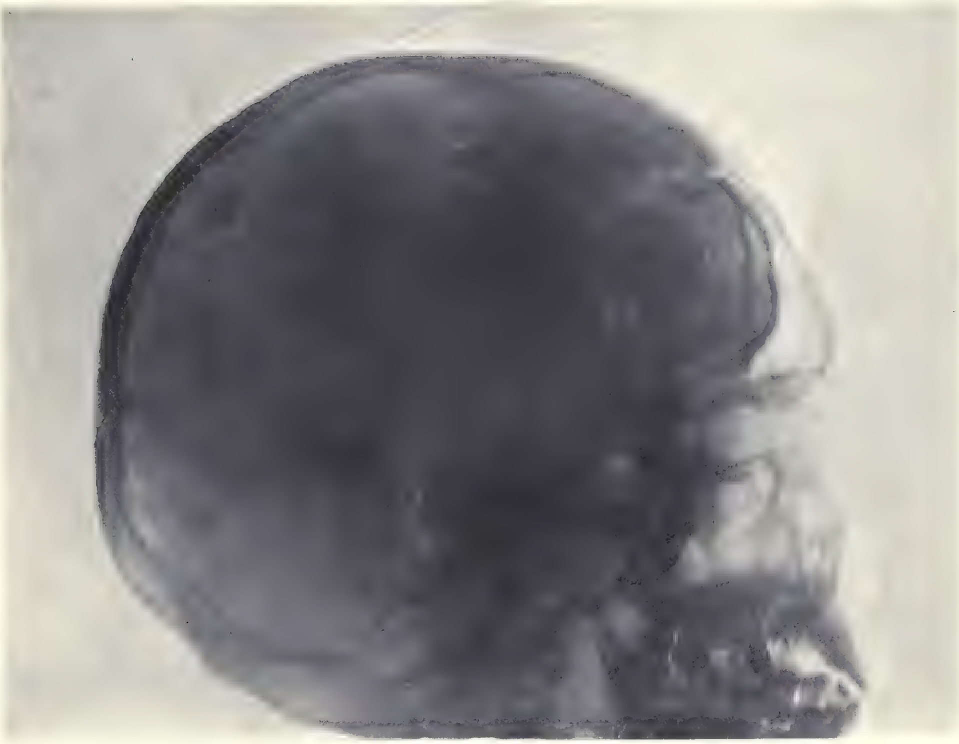
Another is that of Mr. T. T. Higgins', which, in spite of a depressed comminuted fracture and a long crack extending some two-thirds of the length of the vault, did well. (Case No. 3.)

I know of several others, and have been impressed by the connection of extensive fracture and good recovery. Thinking over the matter, does this point to the fact that long fractures are more efficient in relieving pressure than localized small trephining of one inch or so in diameter ? Is a widespread decompression of a certain degree more efficient than decompression of a greater degree in a smaller area ? Some surgeons, of course, remove a large piece of the vault where others would be satisfied in making a small trephine hole, but in that case the bone is removed over the large area decompressed.

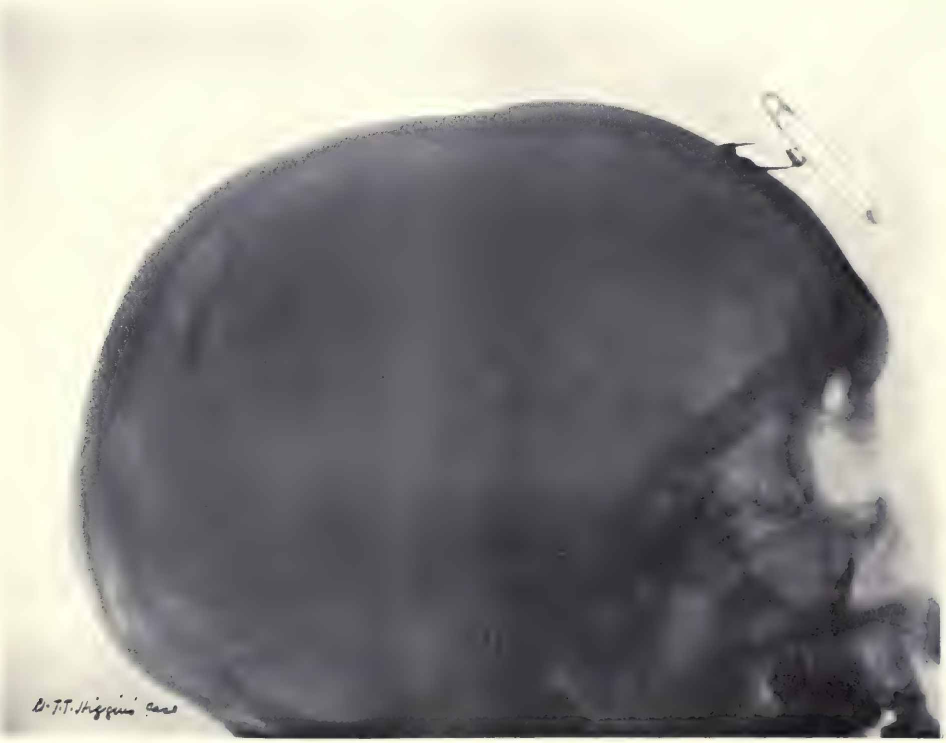
In the cases I am thinking of, the bone remains *in situ*, being only lifted up through intra-cranial pressure. The natural juxtaposition of the bone to the dura and of the latter to the grey matter persists to a great extent, and this must lead to success. It must tend to prevent hernia cerebri and its sequelæ of brain destruction and sepsis. The blood supply of the parts must remain nearly normal.

To end the matter, one wonders whether the lifting of a large area of bone and its replacing after the necessary cleaning of clot, and removal of loose bodies, whether metallic or bony, is not to be preferred to the ordinary trephining and removal of bone by longeur. In the first case mentioned the major part of the fronto parietal skull could be lifted up at will. One must think of future callus entailing further compression, but do not many fractured skulls do well, and go through life without further symptoms except some slight headache, skulls untouched by the surgeon ?

May I add that in most skull cases where localization was necessary we found that two plates giving respectively a lateral and an antero-posterior view were always satisfactory. But careful measurement should be taken with conveyance to the skull previous to operation. The rounding of the cranium



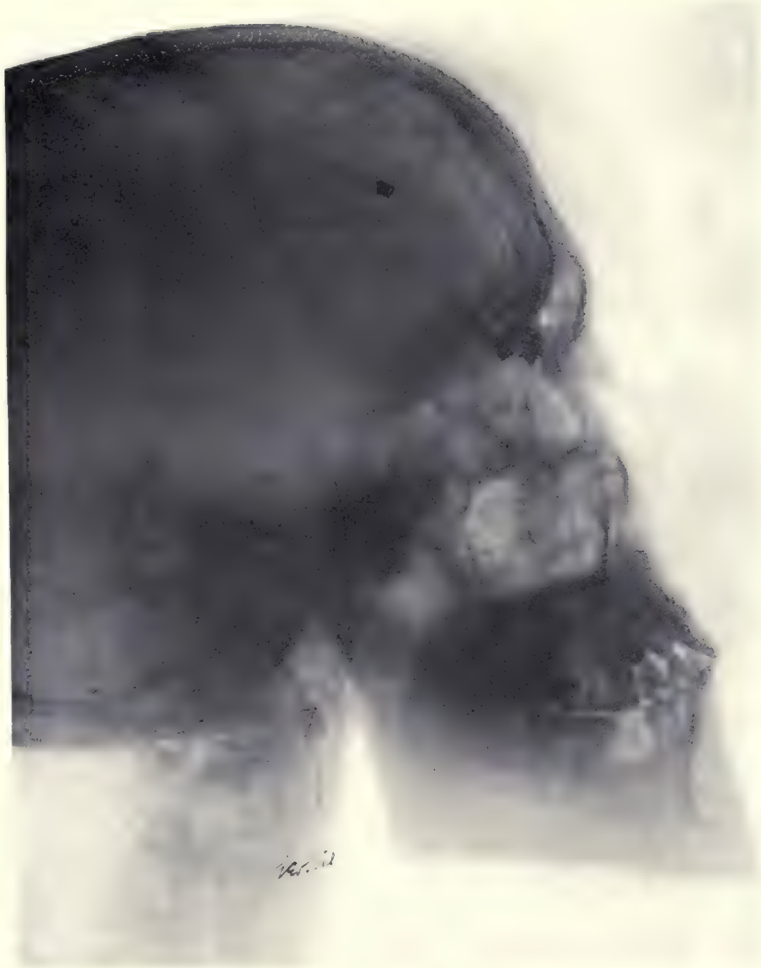
Case No. 2.



Case No. 3.

RADIOGRAPHS OF GUN-SHOT WOUNDS OF THE SKULL.

Plate 33.



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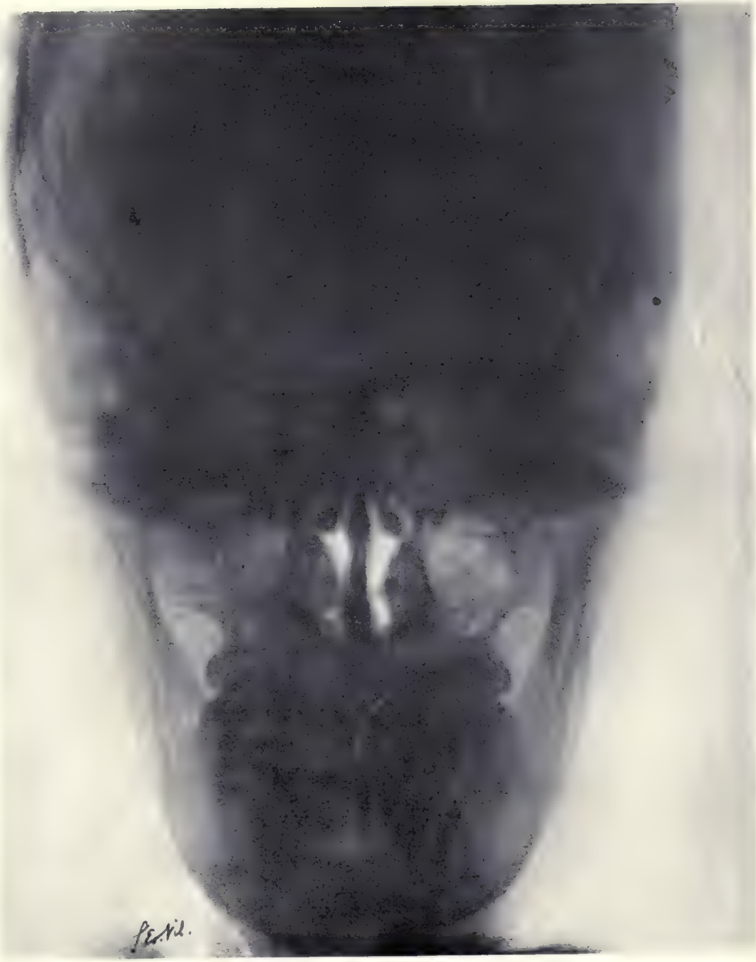


Case No. 5.

Plate 34.

RADIOGRAPHS OF GUN-SHOT WOUNDS OF THE SKULL

may otherwise lead one into error, as I myself was in cases 4 and 5, where the small piece of shrapnel which appears to be lodged well into the frontal lobe was in reality lying on the bone.

To the Staff of No. 16 General Hospital I beg to tender my sincere thanks for permission to publish these few cases, and also for their constant courtesy and help.

HOW TO MEASURE THE THICKNESS OF THE WALL OF AN X-RAY TUBE.

By J. K. A. Wertheim Salomonson (Amsterdam).

We often want to know the thickness of the glass of a Roentgen-bulb, particularly if we have to use it for therapeutic purposes. Some years ago a few firms sold their tubes marked with a number indicating the exact thickness of the glass immediately opposite the anticathode. The present tubes are not marked in this way, though the want of an accurate knowledge of the glass-thickness is quite as much felt as formerly. Yet most medical men have not the leisure or the opportunity to measure their tubes. Generally, they do not even try to do so, as the generally known methods are not very simple.

The methods, best fit for this purpose, are the following :—

1. *Measurement with the microscope.*—If a microscope, fitted with a 0.25 inch objective be first focussed on the outer surface and immediately afterwards on the inside surface of the glass bulb, the difference in position of the microscope-tube, as measured with the micrometer-screw for the fine adjustment, represents the *apparent* thickness of the glass. The *real* thickness is approximately found by multiplication into 1.5, the refraction index of the glass. (Kohlrann's "Lehrbuch d. praktischen Physik," 2nd edit., p. 278.)

Though this method gives fairly accurate results, there is some difficulty in carrying it out, as the construction of most of the modern microscopes does not allow of putting a full-sized Roentgen tube upon the object table. So the microscope has to be taken apart, and the upper part of it, including the parts for the fine adjustment of the tube, have to be mounted in a separate stand before the measurements can be taken.

2. *Measurement with the theodolite.*—This method has been described by *Christen*, of Bern, in the "Fortschritte auf dem Gebiet der Röntgenstrahlen," Vol. XVIII, p. 149, 1911-2, and involves the use of a theodolite. It represents more difficulties than most medical men are willing to surmount, and takes more time than they are able to give, though the principle is simple enough.

3. *Photographic measurement.*—The virtual images of a remote light-spot, formed by the outer and inner surface of the glass can be used in another and far more simple way than by the method of Christen. We have only to provide for a suitable light-spot, for instance, the straight filament of a Nernst lamp, placed at some 5 metres distance, and should take care that *the incident and*

reflected rays make as near as possible *an angle of 90 degrees.* The virtual images are photographed and measured on the negative, their distance apart being l. In this case (viz., 90 degrees between incident and reflected rays) we get the simple relation between the thickness of the glass d, and the distance l between the virtual images :—

$$d = 1.355\ l. \qquad 1)$$

This can be easily proved in this way. AB, an enlarged representation of a section through the glass of the tube. CD, a ray coming from the Nernst lamp, is partly reflected in the direction DK, partly passes into the glass to be reflected in E, and after passing it along EG, leaves it in the direction GL. The distance l between GL and DK is the distance between the virtual images of the Nernst filament.

As the angle made by the incident rays is $\alpha = 45^\circ$ we can write :

$$HD = \tfrac{1}{2}\ GD = l.\ \tfrac{1}{2}\ \sqrt{2}. \qquad 2)$$

In the rectangular triangle EHD we may put $d = EA = HD \operatorname{ctg} (HED)$, and as $HED = \beta$ we get :

$$d = \tfrac{1}{2}\ \sqrt{2}\ l.\ \operatorname{ctg} \beta. \qquad 3)$$

As $1 \text{ in } \beta = \frac{1}{12}\ 1 \text{ in } \alpha$, and $\alpha = 45^\circ$ we find :

$$1 \text{ in } \beta = \tfrac{1}{12} . \tfrac{1}{2}\ \sqrt{2} \text{ and from this } \operatorname{ctg} \beta = \sqrt{2\ n^2 - 1}.$$

Putting this into 3) we finally get :

$$d = l\ \sqrt{n^2 - \tfrac{1}{2}} \qquad 4)$$

As for the blue part of the spectrum, n is about 1.53 for the glass generally used for the construction of X-ray tubes. We get ;

$$d = 1.355\ l.$$

For the practical measurement the best way is to make directly an enlarged negative of the virtual image, the enlargement amounting to some two to ten times. This can be easily done with any long extension camera provided with a short focus lens. A hand camera in which a long cardboard tube is inserted between the lens and the body of the camera is absolutely adequate for this purpose. The enlargement is measured by photographing a glass slip, ruled

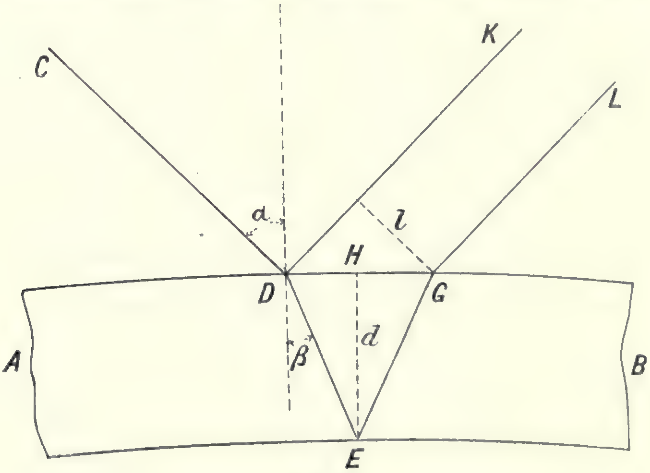


FIG. 1.

to $\frac{1}{10}$ of a millimetre or $\frac{1}{100}$ of an inch, immediately afterwards, and without changing the camera extension. In order to provide for a careful adjustment of the incident and reflected rays at an angle of exactly 90 degrees, it is generally sufficient to place the lamp and the part of the tube which is to be measured at a small and equal distance from the wall of the room, and to place the axis of the camera in a direction perpendicular to the wall. The final adjustment offers no difficulties.

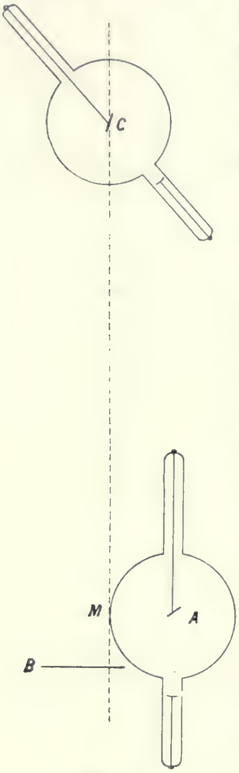


FIG. 2.

4. *Radiographic measurement.*—We can also measure the thickness of the glass of an X-ray tube in a very simple manner by making a radiograph of the tube wall. By taking certain precautions we get extremely sharp negatives which can be accurately measured without difficulty. From this the real thickness can be calculated by one single multiplication. The refraction index of the glass is of course immaterial with this method. Fig. 2 represents our method of making the radiograph of the wall of tube A on a small photographic plate B, wrapped in black paper. We use the rays coming from a tube C. These ray's should be tangential to the part of the wall A that is to be measured, and should fall in a perpendicular direction on the plate B. The distance p from the anticathode of C to the plate B should be carefully measured, and also the distance g from the plate to the point M, when the rays, coming from C, just touch the wall of the bulb A.

If d be the width of the radiographic shadow of the tube wall, the real thickness of the glass is

$$D = d \frac{p - g}{p}$$

In order to get sharp negatives, the distance p should be at least 20 to 30 inches. In C we require a very narrow focus, and moreover the plane of the anticathode surface in C should be placed nearly in the plane tangential to A in the point M. The distance g should be very small, not more that two inches.

The vacuum in tube C should be rather high, so as to give a 5 to 6 inch parallel sparking distance.

After being dried, the negative is measured under any microscope provided with an eye-piece micrometer, an enlargement of ten to twelve times being sufficient.

I have tried both the last methods with small pieces taken from the wall of a broken tube, the thickness of which could be directly measured. Both methods gave results which were in fair agreement with the figures obtained from direct measurement. I do not hesitate to recommend both methods as simple, accurate ones, which do not require any instruments which are not to be found in any well-equipped radiological laboratory.

REVIEW.

Radium, X rays and the Living Cell; with Physical Introduction. By Hector A. Colwell, M.B. D.P.H. (late Assistant in the Cancer Research Laboratories, Middlesex Hospital) and Sidney Russ, D.Sc. (Physicist to the Middlesex Hospital). Pp. x + 324. 12s. 6d. G. Bell and Sons, Ltd., London, 1915.

This volume is divided into two parts. The first part consists of a physical introduction, in which an outline is given of what has been learned about X rays and radio-active substances since their discovery in 1895 and subsequent years. Although this physical introduction is necessarily in outline only, yet the authors contrive, in the small space available, to pick out the salient features of the subject, and to present them in such a way as to link them up with the subsequent portion of the book. It is true that it will not in every case be evident to the medical man what he has to do with some of this knowledge. Facts about wave-lengths may seem rather remote at present from therapeutic practice. Probably no therapeutist has yet measured a wave-length. But the subject is advancing at an extremely rapid rate; and the physicist, who himself was in the same state of innocence five years ago, has come to see that the simplest and most direct way of defining a particular kind of X rays is to state the length of the waves of which it consists. If once the wave-length is known the quality of the X-ray bundle may be considered to be completely defined, just as in the case of light. This volume must therefore be looked at, not as providing information only for the present, but also for the not very distant future.

It is not yet proved to what the therapeutic action of X rays is due. Energy is absorbed in the passage of the rays through matter, and the simplest assumption would be that the effect was due and could be taken as proportional to the energy absorbed. It is improbable that this assumption is valid. Evidence is given in several places (*e.g.* pages 173-174) putting one on guard against too rapid a conclusion. The question is very much complicated by the production of *secondary* radiation, as described in Chapter II. These rays are usually much more easily absorbed than the primary ones. It is possible that a good deal of the therapeutic action is due to them. It is also possible that there is a specific factor as well, because it may be only part of the absorbed energy which is actually utilised, and this available fraction may be different for rays of different quality.

Whether this is so or not, it is known that the amount absorbed plays an important part, and therefore a knowledge of absorption co-efficients is essential. These are dealt with in Chapter III. Hard and soft rays are distinguished by the difference in their absorption. The co-efficients (with respect to a definite absorbing substance, *e.g.*, aluminium) may, in fact, be taken as labels to the different rays to serve until the wave-length label is more easily accessible.

Methods of measurement are given in Chapter I. Considering the importance of these, in connection with investigations of all kinds, a somewhat fuller account of these methods would be desirable. We imagine that the scantiness of treatment reflects the authors' dissatisfaction with most of the existing methods. The need is urgent for the question of measurement to be placed on a securer footing.

The remainder of Part I (Chapters V-XII) deals with radium and its congeners. These substances may be regarded as affording a variety of ways of obtaining agents similar to cathode and X rays, known as Beta and Gamma radiation respectively. But, in addition, they supply a third kind (Alpha radiation), whose ionising action is very intense. A sufficient account is given to put the physician *en rapport* with this fascinating subject.

Part II is the portion that gives the book its title. It commences with an account of chemical actions produced by any of the above agents. The difficulty of the subject is shown by the sometimes conflicting evidence. Most remarkable of any is perhaps that on venoms (page 98); it rests however upon a single authority, who gives only imperfect data. It is to these chemical actions that we must perhaps look in order to find a satisfactory quantimeter of radiations. The second chapter deals with action on miscellaneous forms of animal life, (Protozoa, Hydrozoa, etc.). Chapter III is of special interest, because it is concerned with forms of developing life. The facts adduced are of value in connection with the known harmful effects upon germinal cells in higher animals. Chapter IV includes action on seeds, plants etc., and Chapter V on Bacteria. In Chapter VI a matter of more directly therapeutic importance is introduced: the action on the skin is here treated both in regard to baneful and beneficial effects. Chapters VII and VIII give in great detail ascertained actions on the blood and blood vessels, while IX and X deals with the spleen, thymus and thymoid. Then follow chapters on the action on the digestive and nervous systems, the eye, muscle, cartilage and connective tissues, and an important one on the generative system. Of predominant importance are Chapters XVI and XVII, which are concerned with malignant growths; both the action of rays on such growths, and the artificial production of malignant disease by means of rays. Chapter XIX is physiological, while Chapter XX deals with the vexed question of the selective and differential action of rays.

It will be seen from this mere enumeration of the chapters what a large field is covered. Each subject, moreover, is considered with great thoroughness, a vast mass of material being gathered together on which judgments may be based. References are given in every case to the original papers from which the matter is derived, these references being gathered together for convenience at the end of each chapter. The illustrations (some of them in colour) come out very well, and do justice to the printer; in fact, no pains have been spared to add to the dignity as well as to the utility of the book. We have discovered no "printers' errors."

The general impression left behind after perusal is that an enormous amount of work has now accumulated in connection with this subject, and that it is no longer possible to suspend judgment, although in many cases it has been exceedingly difficult to disentangle the truth from the conflicting evidence supplied by investigators. And this judgment is that in X rays, and in the various radio-active radiations, we have agents which are not only very powerful to harm, but very powerful to bless when properly used. This book should go a long way toward supplying that detailed and exact knowledge which is necessary in order that these agents shall not be misused, but successfully used.

NEW INSTRUMENT.

A NEW TUBE STAND.

This tube stand has the following novel features, differentiating it from any that have previously been designed:—

(1) It is made almost exclusively of wood and other insulating materials, the nearest metal to the tube being over 18 inches distant. This is a very important point in these days of deep therapy and expensive tubes.

(2) The rays can be projected in absolutely any direction, whereas it is frequently found that when a universal joint is employed, the pencil can be sent in any direction except the one desired. In order to adjust the position of the tube, it is only necessary to loosen one milled nut, take hold of the box and place it in the desired position, where it will remain and can be fixed by tightening the clamp. This is a very much simpler process than the several racking, clamping and unclamping operations required in the average stand.

(3) The tube box is accurately counterpoised in every direction whatever position it may be in, a condition not even approached in any other stand. Even in those stands where the weight of the tube box is counterpoised, unbalanced strains invariably occur, owing to the unsymmetrical arrangements In this stand the lever or cell principle, com-

bined with the method of carrying the tube box, absolutely eliminates all unbalanced strains.

(4) The tube box can be changed from the upward to the downward pointing position without crossing the wires or disconnecting. This saves considerable time and is a great convenience, enabling work to be done in every position without any trouble due to reversal of the tube.

(5) The whole of the moving parts are correctly balanced about the central pillar, around which they can be freely rotated. This balancing, together with the heavy base provided, make it practically impossible to overturn the stand.

(6) A heavy base is fitted which normally stands solidly upon the floor. To shift the stand bodily, one turns a small handle near the base, this raises it on three castors to enable it to be freely moved. For taking it up and down stairs, hand holes are provided in the base, and two people can readily carry it. One man can carry the stand without much difficulty.

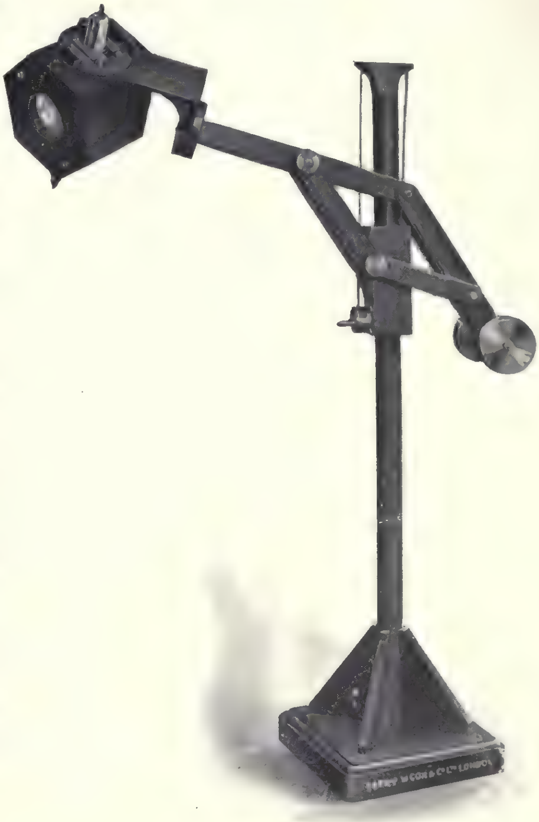
(7) The range of motion is 5 feet in the vertical and over 18 inches in the horizontal direction.

Other good points which it possesses, but which cannot be claimed exclusive, are:—

(8) A stereoscopic or localizing shift.

(9) Good protection by 3 mm. of lead rubber of over 4.5 specific gravity.

(10) Very convenient methods of fixing diaphragms, specula, filters, etc.



The stand is designed, patented and manufactured by Messrs. Harry W. Cox & Co., Ltd., Tennyson House, 159-161, Gt. Portland Street, London, W.

NOTES AND ABSTRACTS.

"Trench-Back" treated by ionisation with salicylate.—John D. Sanders, Captain I.M.S., *British Medical Journal*, 1915.—"Trench-Back" is the term applied to a variety of conditions arising from injury to the back in the lumbar or sacral regions. The injury is usually caused by the impact of large and heavy masses of matter, such as a quantity of earth, or sandbags.

The cases almost invariably come from the trenches. They complain of pain and rigidity in the dorso-lumbar region. Various degrees of disability are represented—some can get about, others have to be carried on stretchers. Those who can walk do so with a pronounced stoop, and use a stick. Tenderness is generally present. Some cases show anæsthesia, and in these there is probably spinal injury. In the milder cases the clinical picture is that of marked lumbago, and would be indistinguishable except for the history. All cases of this condition should be examined by X rays before being treated in the manner suggested, and all cases of injury to the spine and pelvis excluded. Cases with anæsthesia of the lumbar and sacral regions are unsuitable for ionisation, as they are very liable to be badly blistered during treatment. The majority have no spinal lesion, the symptoms being due to contusion or sprain of the muscles and fasciæ alone. It is for cases of this class that the author advocates ionisation. In a certain proportion a pronounced psychical factor can be traced, and these cases present features similar in many respects to the condition known as "railway spine," and are always difficult to treat.

The author applies the treatment to all cases of trench-back coming to the department, and the results so far have been satisfactory. It is applied as follows: A 1 per cent. solution of sodium salicylate is prepared. (This can be conveniently done with Burroughs Wellcome's soloids for ionic medication.) A large pad sufficient to stretch right across the back, and 8 or 10 in. broad, is saturated with the solution. The pad must be composed of at least six layers of lint. The patient is placed face downwards on a couch, and the pad is laid over the painful area. A mail chain electrode is placed on top of the pad, and the whole firmly bound on with a bandage. The mail chain electrode is connected with the negative pole. The current is gradually turned on and treatment continued for about fifteen minutes. Thirty milliampères is the usual amount to be given at the initial treatment. At subsequent applications this can be increased until the patient is taking 100 milliampères, or even more. Some cases tend to blister readily even with small currents, and allowances must be made for individual differences. As a general rule the higher the milliampèrage that can be borne, the better and quicker will be the results, always remembering that the size of the electrodes must be proportionately increased.

Applications are carried out twice weekly, and improvement often occurs after the first. Some cases are cured in two or three applications.

Radium in Cancer of the Bladder.—WINFIELD AYRES, M.D., writes ("New York Medical Journal," Feb. 20, 1915), on the beneficial results of the treatment of inoperable cases of cancer of the bladder by radium. He says that radium rays are more easily screened, more easily applied, and, when properly handled, less dangerous to the patient than Roentgen rays. Especially is this the case in neoplasm of the bladder, where radium may be brought in direct contact with the tumour, an impossibility with the Roentgen rays. Against radium is the enormous cost of sufficient quantity to be effective.

It is the general opinion, the author states, that too small a dose of radium will increase cell proliferation and a consequent more rapid growth of the tumour, but a proper dose causes disintegration of cellular structure. Reports that radium, instead of improving cancerous conditions, increases the rapidity of growth of the tumour, probably concern cases which have received entirely too little radiation. A slow growing tumour requires less radiation than one of rapid growth.

The case described by the author was inoperable. The patient was 72. He had 3 per cent. of sugar in his urine. The growth was sessile, one inch in all diameters and projected from the wall of the bladder in the region of the orifice of the left ureter. On account of the general condition of the patient a surgical operation for removal of the growth and transplantation of the ureter would probably have been fatal.

Some means had to be devised for direct application of the screened capsule of radium. The instrument was described in the "New York Medical Journal" for July 18, 1914. An operating cystoscope was used. Radium, enclosed in a special capsule attached to the end of a holder, was passed along a side-channel of the cystoscope on to the growth, illuminated by the lamp. Gold was selected for screening, because an extremely thin layer of this metal is sufficient to shut off the alpha and primary beta rays. Because of the difficulty of use and the nature of the tumour, a capsule of ten mgm. of radium was first employed, but this proving insufficient, the amount was doubled and again doubled. The use of the larger quantities was made possible by discovery of a cystoscope of unusually large capacity, and the second doubling was accomplished by using a higher concentration of radium.

It was necessary to use anæsthetics, and the method which proved most satisfactory was to allow two ounces of a 1 per cent. solution of alypin to remain in the bladder for one half-hour, and a 1 per cent. solution of cocaine in the urethra for ten minutes before the cystoscope was introduced.

Treatment by this method requires a careful observation of asepsis, a very gentle hand, a steady nerve, infinite patience, care of the bladder on the off days, and hearty co-operation of the patient. Cystoscopy three times a week of a few minutes duration, is quite a tax on the resistance of the bladder and urethra, but when each sitting is prolonged for one hour, the danger of infection is still greater.

The question might arise as to why the cystoscope is necessary. Passage of a flexible container for the radium would certainly be easier on patient and physician, but there would be no certainty that the capsule would ever come in direct contact with the neoplasm. It certainly would come in contact with the normal bladder wall, and there would be no way of screening it from healthy tissue. But with the cystoscope the radium may be held in direct contact with the tumour all the time and the healthy bladder wall is kept from it by fluid—a poor screen, but the farther away from tissue, the less effect has radium on it. Therefore the writer believes the best results will be obtained by applications under direct vision.

In the case reported 10 mgm. of radium were used. Applications were made three times weekly, each lasting thirty minutes or longer. The tumour began to disappear, the blood to cease and large pieces of necrotic tissue to appear in the urine in about two weeks. But after two months improvement ceased. A new cystoscope was then used, and this was of much greater capacity, so that 20 mgm. of radium could be applied. Applications were resumed, twice weekly, each lasting one hour. Under the stronger radiation the remains of the tumour began to disappear rapidly. Five months after the first application (with the 10 mgm.) there was no evidence of cancerous growth.

NOTICES.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

Editors.

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IN COLLABORATION WITH

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RADIOGRAPHY OF THE CHEST IN CHILDREN.

By W. J. S. Bythell, B.A., M.D. (Capt. R.A.M.C., T.F.)
Hon. Physician to Ancoats Hospital, Manchester (Electrotherapeutic Department), Medical Officer to the X-ray Department of the Manchester Children's Hospital, etc.

In all essential respects the X-ray examination of the chest in young children is carried out upon much the same lines as in adults. It is of the greatest importance, however, to gain thoroughly the confidence of the patient from the outset, not merely for the personal comfort of the operator, but also in order to arrive at a reliable diagnosis. As a rule it is quite easy to control children of two or three years, especially with the assistance of the mother or a tactful nurse. In hospital practice it is advisable to allow the younger children to see the older ones examined first.

The screen examination should be conducted in the upright position, either with the child standing against the screen, or sitting upon a stool and holding the screen in front of the chest. If, however, the child is quite unmanageable it is much better to make the examination upon the couch with the tube beneath ; in such cases the violent crying must serve to show the nature of the diaphragmatic movements.

As regards the apparatus, a coil or transformer capable of taking instantaneous radiograms is necessary for the best results. The tube-holder should have an aperture large enough to show the whole thorax upon the screen, but it is essential also that the operator should be able to localize down for the examination of small areas ; in no other way is it possible to see the finer details clearly.

Foreign Bodies in the Thorax.—Foreign bodies in the œsophagus and respiratory tract are more frequently met with in young children than in adults, and they include a very large variety of objects, such as pins, buttons, coins, metallic toys, etc., which children are fond of putting into their mouths. Most of these are easily discovered upon the screen, but ordinary pins are not readily detected, even with a good apparatus. If the screen examination gives a negative result, a series of plates of the chest may be taken when it is important to obtain a definite diagnosis. In the majority of cases the foreign body will be found impacted at the level of the costo-clavicular joints, especially if it be a coin (Fig. 1), or at the cardiac orifice.

Its localization is usually not difficult, but if there is any doubt as to whether the object is in the œsophagus or the trachea a spoonful of bismuth paste will serve to indicate the position of the former. The same procedure should also be adopted when examining for objects which are quite transparent to the rays, when partial or complete stoppage of the bismuth will reveal the presence and position of the foreign body in the œsophagus.

Foreign bodies in the bronchi will usually be found close to the root of lung (Fig. 2), but we have seen a small round pebble at a distance of over two inches from the hilus in a child of four. In such cases a good radiogram should be obtained before giving a diagnosis ; we have seen a case diagnosed upon screen examination as a button in the bronchus, whereas an instantaneous radiogram showed the shadow to be a small round calcareous focus near the root of the lung.

In all cases the examination is facilitated by the ease with which the thorax of a child can be screened from any desired angle.

Examination of the Mediastina.—It is often difficult in small children to get a clear view of the posterior mediastinum in the semilateral position, but a good plate of the lateral view can generally be obtained, and this will often give valuable information (Fig. 5).

The presence of enlarged mediastinal glands (in tuberculosis or Hodgkin's disease), new growths, or spinal abscesses will be indicated by shadows obscuring the lateral or semilateral view, or bulging on either side of the aorta in the front view of the chest.

The X-ray diagnosis of spinal abscess in the thoracic region is often important from the surgical point of view. The abscess, if sufficiently large, will be visible upon the plate or screen as a rounded shadow bulging on both sides of the middle line. A shadow such as that seen in Fig. 3, when associated with spinal caries in the cervical or upper dorsal region, leaves no room for doubt as to the diagnosis.

Examination of the Œsophagus.—Little need be said in reference to the X-ray examination of the œsophagus in children ; in all technical details it resembles that of adults.

Obstruction of the œsophagus is met with in quite young infants, either in the form of congenital stricture or diverticula, or of acquired constriction. In older children it is seen also as the result of swallowing caustic or irritant fluids. (See Figs. 4 and 5.) The obstruction may be either organic (*e.g.*, cicatricial), or spasmodic, or due to a combination of both elements.

There is, as a rule, no difficulty in persuading young children to take the bismuth mixture, provided a liberal allowance of sugar is added. For infants the bismuth may be mixed into the ordinary contents of the feeding bottle.

Examination of the Lungs.—The fluorescent screen plays a very important part in the diagnosis of pulmonary lesions in children. The examination should always commence with a thorough inspection of the thorax with the aid of the screen, radiograms being taken subsequently, whenever necessary, to confirm any doubtful points, or to obtain a permanent record.

The screen examination is particularly easy in young children, on account of the translucency of the parts. The shadows are also seen very much more sharply than in adults owing to the proximity of the lung structures to the surface of the screen. With a good X-ray apparatus and a certain amount of practice, it should be easy to see even the faintest pathological mottling in the lungs, and to readily distinguish it from the normal shadows. In fact, it is no exaggeration to say that an experienced observer should be able to see upon the screen practically everything in the thorax of a child up to the age of ten or twelve years that can be rendered visible in a radiogram. The finer details, as we have said, can only be seen distinctly by localizing the beam of rays so as to illuminate a small area at a time. The Coolidge tube is particularly well suited for this purpose.

The points to which attention must be directed during the screen examination are (1) the movements of the diaphragm and ribs, (2) the lighting up of the lungs during inspiration, and (3) the presence of abnormal shadows.

Pulmonary Tuberculosis.—Many writers have published series of observations showing that in children, at all events, the most frequent seat of origin of pulmonary tuberculosis is at the root of one or both lungs, and in the writer's experience this holds good in practically every case.

There can be little doubt that infection of the bronchial glands by the tubercle bacillus is of very frequent occurrence in childhood, and particularly so in children living in the poorer quarters of large towns. In the majority of cases this infection is overcome, and leaves nothing more serious than a more or less completely calcified gland, which will be visible upon the screen or plate as a dark shadow close to the hilus of the lung. In others, however, the gland succumbs to the infection, caseates, and finally breaks down; the infection then extends directly to the surrounding lung tissue, and so starts a tuberculous bronchopneumonia at the hilus. A screen examination at this stage will reveal ill-defined mottling extending into the lung substance, where normally there should be nothing visible except the fine streaky shadows radiating from the hilus which are caused by the branching bronchi. According to Jordan, the extension of the disease takes place along these bronchi (peribronchial phthisis), but it is important to note that in chronic bronchitis there may be an accentuation of the normal bronchial shadows in the absence of tubercular disease. The shadows in such cases are still of the streaky or linear type, and are quite unlike the blurred and mottled shadows seen in tuberculous bronchopneumonia. (See Fig. 6, and compare this radiogram with that shown in Fig. 1.)

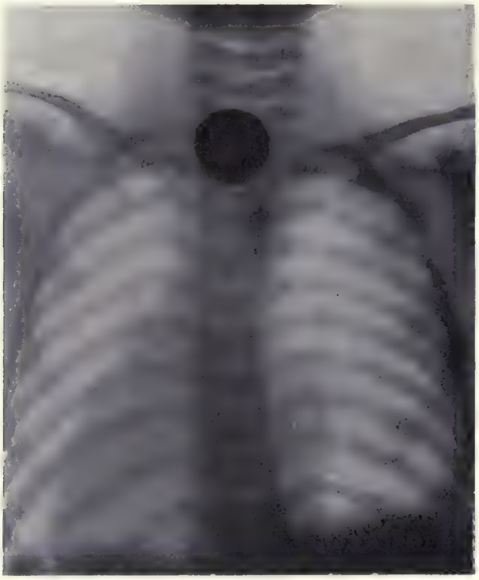


Fig. 1.—Halfpenny in Œsophagus. Age 5

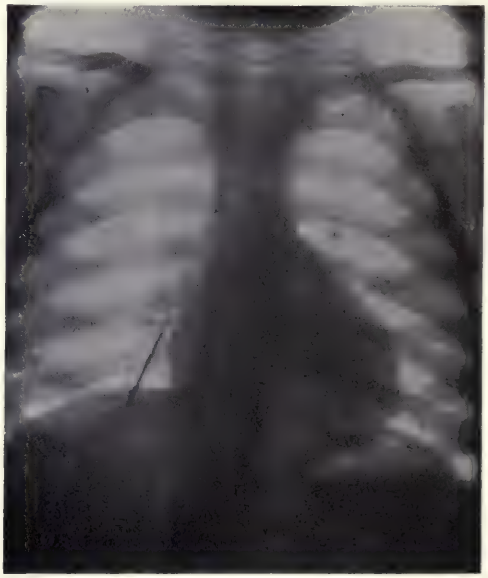


Fig. 2.—Pin in Bronchus (right lower lobe). Age 7½.

It is also essential for the observer to have a clear conception of the appearance of a normal chest upon the screen, and this can be obtained only by constant practice in the examination of children at different ages. In a child who has not been subjected to a tuberculous infection of the roots of the lungs there is visible nothing but the fine radiating bronchial shadows already described, unless the bronchi have become thickened as the result of chronic bronchitis, in which case these structures may be unduly prominent upon the screen or plate. In the majority of "healthy" children, however, evidence is to be found of old glandular infection in the form of one or more well-defined and opaque nodules at the roots, and in many instances these will produce shadows as dense as those caused by leaden shot. In others the

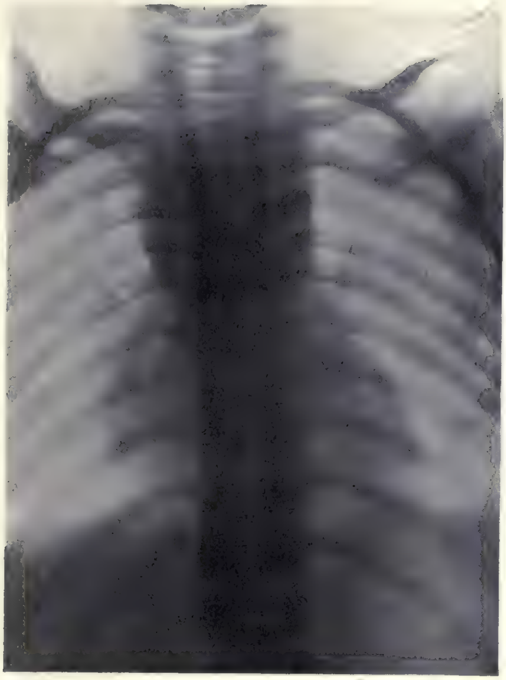


FIG. 3.—Spinal Abscess (caries of cervical vertebræ). Age 3.

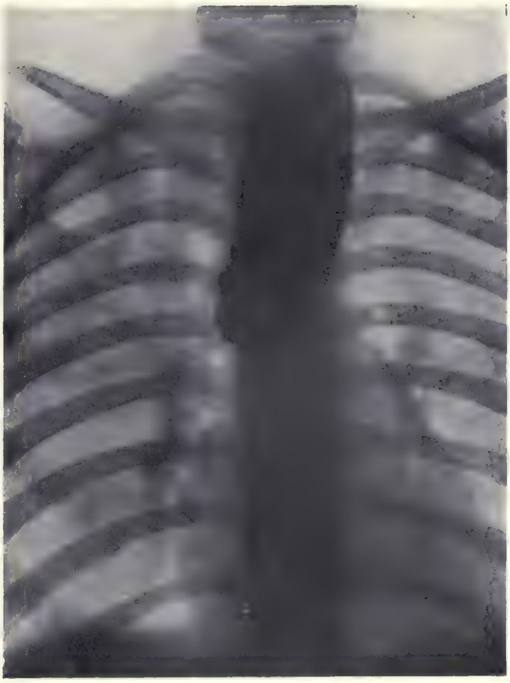


FIG. 4.—Œsophageal Obstruction (antero-posterior view). Age 6.

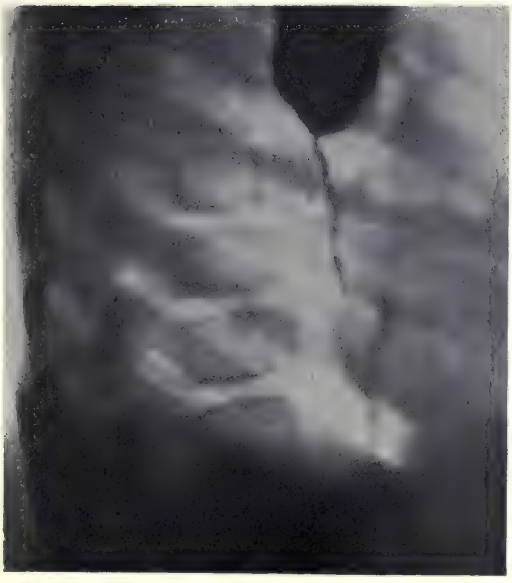


FIG. 5.—Œsophageal Obstruction (lateral view of thorax). Age 6.

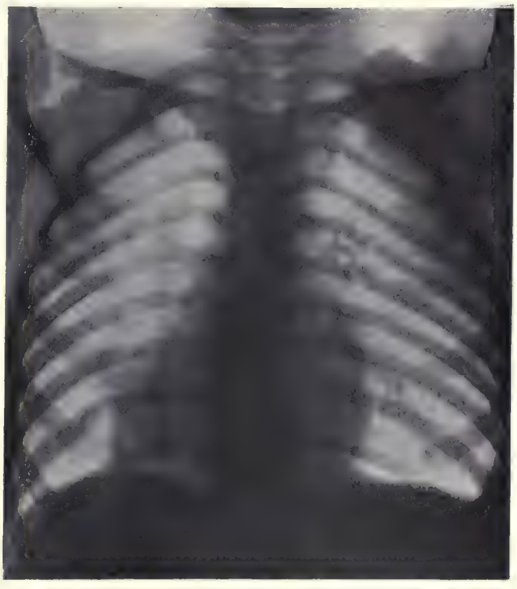


FIG. 6.—Early Hilus Tuberculosis (bilateral, but most extensive on right side). Age $7\frac{1}{2}$.

RADIOGRAPHY OF THE CHEST IN CHILDREN.

By W. J. S. BYTHELL, B.A., M.D.

PLATE 35.

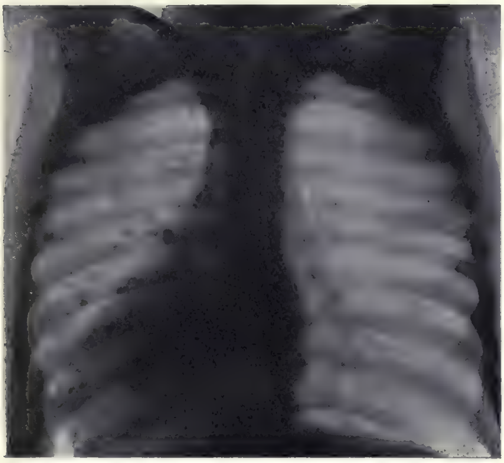


FIG. 7.—Old Calcified Tuberculous Foci in Left Lung. Age 7.

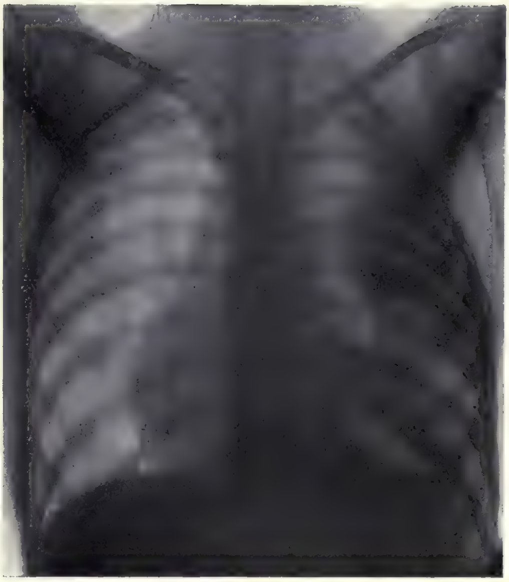


FIG. 8.—Chronic Fibroid Pleurisy (right). Age 10½.

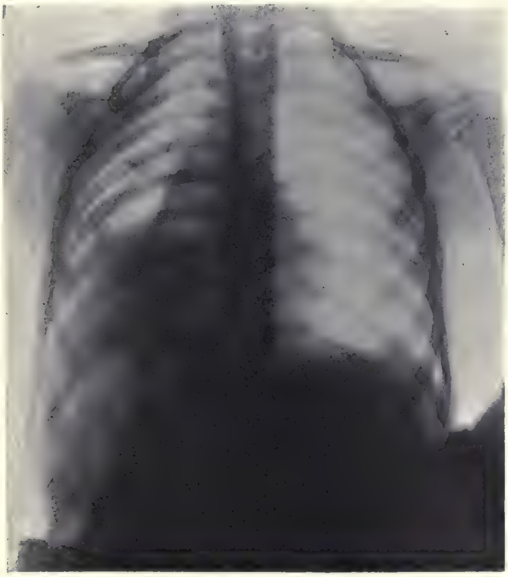


FIG. 9.—Left Empyema. Age 6.

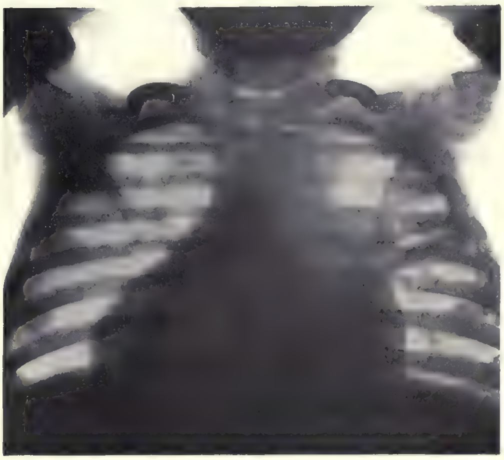


FIG. 10.—Chronic Mediastino-pericarditis, with Emphysema. (Note absence of cardio-hepatic angle). Age 5.

RADIOGRAPHY OF THE CHEST IN CHILDREN.

By W. J. S. BYTHELL, B.A., M.D.

PLATE 36.

foci may be seen scattered about the lungs, denoting the presence of healed areas of tuberculous bronchopneumonia (Fig. 7).

The distinguishing features, in fact, between old and recent foci are the opacity and sharp definition of the former as contrasted with the softer and less opaque mottling caused by active disease. When there is room for doubt as to the activity of the lesion, the question must be settled upon clinical grounds, and the case kept under periodical observation to note progress of the disease. It may be urged, indeed, that in no other branch of radiography is it so necessary to combine together the X-ray and clinical evidence as in the diagnosis of early hilus tuberculosis in young children. For instance, in many cases the X-ray examination will reveal faint mottling at the root of one or both lungs, but these shadows may be so slight that a definite diagnosis of tuberculosis may not be justified, or it may be impossible to decide whether the infection is active or quiescent. In such cases, a clinical history of cough, irregular pyrexia, night sweats, and so on, would fully establish a positive diagnosis of active pulmonary tuberculosis in an incipient stage. In this connection it is also very important to bear in mind that definite X-ray evidence of hilus disease may be forthcoming when there is entire absence of physical signs, or, at most, some suspicion of diminished resonance over the roots posteriorly, combined perhaps with a suggestive history of general ill-health. In such cases the great value of an early diagnosis by means of the X rays is obvious.

Collateral information is sometimes supplied during the course of the screen examination by limitation of the diaphragmatic movements of one or both sides. Such limitation is of great value as a positive sign in doubtful cases, but normal movements by no means negative even comparatively extensive pulmonary disease. Defective lighting up of one of the lobes during deep inspiration is of greater significance when associated with even the faintest mottling in the same lobe.

The size of the heart has also been regarded by some observers as a feature of some diagnostic importance, a small heart being typical of early pulmonary disease. We have certainly noted this peculiarity in a number of cases, but do not attach any great value to it.

In our experience the earliest signs of hilus infection are more frequently met with at the right root than at the left. In 200 consecutive cases of early disease that we have examined, the right root was affected in 37·5 per cent., the left in 20·5 per cent., while in the remaining 42 per cent. there was early disease at both roots.

In *advanced cases* the presence of extensive shadows will denote the spread of the disease into one or more lobes. A definite line of extension towards the apices may be visible, but it is only in comparatively exceptional cases that there is much apical consolidation in young children, and then only when there are very advanced lesions in other parts of the same lung. In all cases that the writer has examined the heaviest shadows have been near the root of the lung, and the general appearance has strongly suggested origin of the process in that region.

The usual X-ray indications of cavitation, or of pleuritic thickening, may also be present in long-standing cases.

The acute miliary type of pulmonary tuberculosis is much less frequently met with. The few cases seen by the writer have constituted the sole exceptions to the usual form of hilus tuberculosis. The fluorescent screen and plate show fine discrete mottling evenly distributed throughout both lungs. The diaphragm does not appear to be affected in early cases.

In *acute bronchopneumonia* the X-ray examination also reveals the shadows of consolidated lung-tissue. Their distribution, together with the absence of root shadows, may throw some light upon the diagnosis, but there is no intrinsic peculiarity in the appearance of the mottling to distinguish it from that of tubercular consolidation. In doubtful cases, however, the nature of the clinical history should suffice to establish the diagnosis.

Much useful information may also be obtained by X-ray methods concerning the differential diagnosis of other forms of pulmonary disease, such as *pulmonary fibrosis*, *abscess of the lung*, or *pneumothorax*. A screen examination should also serve to distinguish a pulmonary or mediastinal *tumour* from a pulmonary consolidation, as well as to show its exact size and position. The radiology of these conditions in children presents no special features.

Examination of the Pleura.—The normal translucency of the pleura may be interfered with either by acute inflammation (fibrinous, or with effusion), or by chronic thickening. In the latter case the appearance upon the screen is that of a general greyness, through which the shadows of the ribs may be just visible, and extending perhaps from the apex right down to the base (Fig. 8). In extreme cases, when the opacity is very marked, it may be difficult or impossible to decide to what extent the shadow is due to concomitant pulmonary consolidation.

Acute pleurisy is usually more localized, and especially to the axillary line. The density of the shadow is greatly increased by the presence of fluid, and it is worth noting that we have seen evidence of free pleuritic fluid—that is to say, fluid which finds its own level upon tilting the patient sideways—much more often in children than in adults. Apart from such change of level it is impossible to make a certain diagnosis of pleuritic effusion unless there is a sufficient amount of fluid to produce a dense black shadow. Nor is it possible to judge between a serous effusion and an empyema by the appearance of the shadow. An X-ray examination is frequently of invaluable service, however, as a means of localizing a small empyema which has escaped detection by clinical methods (Fig. 9), and a screen examination should be invariably made in every case of bronchopneumonia whenever there is the least reason to suspect the presence of pus. We have also known cases in which a needle had been inserted several times without success where the screen at once showed an interlobar empyema.

Examination of the Heart.—A screen examination of the thorax is sometimes useful in congenital heart disease, and also in dilatation resulting from other causes (valvular disease, post-febrile toxæmia, etc.). Much useful information may be gathered in these cases as to the general shape and behaviour of the heart, and as to the chambers of the heart which are involved.

In pericarditis and pericardial effusion, in addition to the general increase in the heart shadow, an important diagnostic point to be looked for is the loss of the "cardio-hepatic angle," the acute angle normally formed by the outline of the right side of the heart with that of the upper surface of the liver (cp. Fig. 6) ; its absence is a perfectly reliable indication of the presence of pericardial fluid, or of great thickening of the pericardium (Fig. 10).

It may also be necessary to note the position and size of the heart and aorta in displacement due to pulmonary or pleuritic disease, intrathoracic tumours, or transposition of the viscera.

THE ORGANIZATION OF THE X-RAY DEPARTMENT OF A GENERAL HOSPITAL IN FRANCE.

Captain A. Howard Pirie, No. 3 Canadian General Hospital.

Introduction.—The first work done in connection with the X-Ray Department was a visit to New York, where a type of apparatus was arranged for and seen being built. Two such apparatuses were ordered and transferred to Ottawa, where we unpacked, tested, and repacked them. They arrived in France in good condition.

Preparatory.—Previous to the opening of the Hospital, the X-ray Staff were kept busy making preparations for the opening of the Department.

The quarters allotted are:—

1. X-ray Room.
2. Developing Room.
3. Engine Room.
4. Tent.

This was found sufficient. A fluoroscopic room would have been an advantage.

The X-ray room was made light tight with blinds specially built for the purpose, so that the room could be quickly lightened and darkened. An X-ray table was built from a standard table as used in the wards, with an X-ray proof tube box under the table. The wires carrying the current were placed in an underground tunnel, and led through the floor to the X-ray tube under the table, thus avoiding any chance of shock to the operator or spectators. This has proved satisfactory in every way. An upright fluoroscope was also built, and has proved equally satisfactory.

The tent was used for storing packing cases, of which there were about twenty; it was also used for drying the plates and demonstrating the plates in the Wheatstone Stereoscope. The storing of the packing cases proved very useful as the hospital has been moved to other quarters.

Apparatus.—Two X-ray machines of the type known as "Interrupterless Transformers" were supplied to the department. Each machine consisted of a 10 H.P. petrol engine of the "Marine" type, a 2 K.W. Generator, and a 2 K.W. Transformer, supplied by Messrs. Waite and Bartlett, of New York. The two machines were similar, with parts interchangeable; so that if both broke down, one could be repaired by borrowing from the other machine. Owing to this, one apparatus has always been in working order. Each machine can be taken apart and packed in four boxes for transport. Four men can carry the heaviest box (480 lbs.).

Tubes.—Of 32 tubes despatched nine arrived broken, so that there were 23 to start work with. All the tubes were 7 in. in diameter, with solid tungsten targets. All accessories, such as plates, paper, lamps, aprons, gloves, chemicals, etc., arrived undamaged, and nothing was lacking in equipment.

Staff.—The staff consisted of two captains and three orderlies. At times, an extra orderly was required to carry patients, when the Department was very busy after the arrival of a convoy.

Opening of the Department.—On August 8th, 1915, the Department opened, and 14 radiographs were made. On the third day 83 were made, as well as many fluoroscopic examinations and localizations of foreign bodies. On this occasion one machine was at work from 8.30 a.m. to 7 p.m., and broke down. The armature burned out owing to too constant and prolonged use. No precautions had been taken to save it, the requirements of the patients alone being considered. Since then the other apparatus has been in daily use, and precautions have been taken that it is never overtaxed. It is still in perfect order. A new armature was ordered, and despatched on 21st August, by Messrs. Waite & Bartlett, of New York, by steamship, and arrived three months after leaving New York. The burnt armature was sent to London for repairs.

Routine.—When an examination of a patient is required, the following requisition form is filled out by the Medical Officer in charge of the case, and sent to the Department :—

CANADIAN GENERAL HOSPITAL.—X-RAY DEPARTMENT.

Surname ....

1st Name ....

Regtl. No. ....

Unit ....

Bde. or Div. ....

Nationality ....

Injury ....

Wounded at ....

Ward ....

Provisional Diagnosis ....

Information Desired ....

Referred from ....

Patient can walk ....

Patient requires a stretcher ....

An orderly from the department takes this form to the ward, and with the help of the ward-orderly, returns with the patient. The ward-orderly helps with the return of the patient ; if the patient can walk the ward-orderly is not required.

All requisitions are attended to the same day as required, but on three occasions some of the less urgent cases have been left over till the following day, owing to the pressure of work. This delay has been caused by:—

(1) The lack of the second apparatus.
(2) The length of time required to move a seriously wounded, helpless patient.
(3) Heavy rain.
(4) Darkness, rendering the transport of patients difficult and dangerous after 5.30 p.m.

At no time has a patient suffered from want of X-ray attention.

Radiographs.—By the use of paper, instead of plates, we have, as occasion required, been able to show a surgeon an X-ray photograph of his case one minute after the taking of the photograph. As a general rule all radiographs are developed at once, and ready for inspection half an hour later. During rush times it has been found more practical to show to the surgeons their radiographs during the evening after the work of the department is finished. This avoids stopping the X-ray work during the day in order to consult with the surgeons, and is a great saving of time to the department.

From August 8th to November 5th, 1915, 1,540 X-ray photographs and many fluoroscopic examinations were made. X-ray treatments were given for sycosis and rodent ulcer and exophthalmic goitre.

No X-ray burn or other untoward effect has been caused to patients or staff. Stomach examinations by barium meals have been carried out when required. The nature of the findings has been approximately in the following proportions:—

Foreign bodies	60	per cent.
Negative diagnosis	30	,,
Fractures	5	,,
Diseases	5	,,

Localization Methods.—The following methods of localization have been used in the Department:—

1. A modified Mackenzie Davidson method.
2. Stereoscopic.
3. Anterior, posterior and lateral views, with metal ring on wound of entrance.
4. Fluoroscopic localization.
5. Placing a needle with its point in contact with the foreign body, using the fluorescent screen for the purpose.
6. "Snook's" modification of "Sweets" method for foreign bodies in the eye.

The first-mentioned method has proved very satisfactory, and except for foreign bodies in the eye has been used nearly exclusively.

Records.—The method adopted at first for keeping records was that which we had used in civil practice for many years, viz. :—

1. A numerical book.
2. A card index of names of patients.
3. A card index of diseases.

Supplies.—A fortnightly supply of plates, paper, chemicals, etc., has been received regularly, and at no time has the Department had to stop work through want of supplies.

Conclusion.—Coming as we did to unknown conditions, it has been a source of great satisfaction to us that every case has been as well treated in this Department as it would have been in a large civil hospital. The quality of the radiographs has been as good as that seen in civil practice. The apparatus has been in good order every day so that no day passed when X rays could not be had.

It is a pleasure to record the cordial support and co-operation which we have received at all times from all Departments, and the efficient and liberal manner in which we have been supplied with all necessities.

A CONVENIENT RADIUM EMANATION TABLE FOR CLINICAL WORK.

By **Walter C. Stevenson**, M.D., B.Ch., D.P.H.,
Surgeon and X-ray Officer, Dr. Steevens' Hospital; Surgeon, Orthopædic Hospital, Dublin;
Captain R.A.M.C. (Temporary).

A Paper read before the Surgical Section of the Royal Academy of Medicine of Ireland, 20th January, 1916.

On the 5th of November last I had the honour of reading before this Section a paper on a method of recording radium dosage, illustrated by a series of eleven cases treated by one set of radium emanation capillaries in needles.(1) The emanation was used for ten days, till the quantity present was reduced from 37·8 millicuries to 6·2 millicuries. There were fourteen doses administered, and in each dose the average amount of emanation used with the patient had to be calculated by a series of multiplications, the multiplying factor being obtained from a table showing the decline of activity of 100 millicuries at certain intervals of time. Most tables available up to the present seem to be published rather for their academical interest than their practical value. Using even an extended table, such as I showed you, to ascertain the activity of 37·8 millicuries in two days, two hours, it is necessary to multiply together 37·8, ·697, ·9925, ·9925. "Multiplication is vexation," and an approximation is most likely substituted, which in turn is often used as a basis of another approximation. Even if the figures are actually calculated, mistakes are liable to occur, as I know to my cost, which will vitiate all the later figures. I have found that all this drudgery is avoided by the use of the table before you, which shows me at a glance not only that the activity of 37·8 millicuries in two days two hours is 25·9 millicuries, but also its activity at any intermediate or subsequent hour.

Table showing the hourly decrease of Radium Emanation after reaching its maximum, or radium C equilibrium, four hours after collection.

DAYS.

Hours	0	1	2	3	4	5	6	7	8	9	10	11	12	Hours
0	1000	835	697	582	486	406	339	283	236	197	165	137	115	0
1	993	829	692	578	482	403	336	281	235	196	164	136	114	1
2	985	823	687	573	479	400	334	279	233	194	162	135	113	2
3	978	817	682	569	475	397	332	277	231	192	161	134	112	3
4	970	811	677	565	471	394	329	275	230	191	160	133	111	4
5	963	805	672	561	468	391	327	273	228	190	159	132	111	5
6	956	799	667	557	465	389	325	271	226	188	157	131	110	6
7	949	793	662	553	462	386	322	269	225	187	156	130	109	7
8	942	787	657	549	458	383	319	267	223	186	155	129	108	8
9	935	781	652	545	455	380	317	265	221	184	154	129	108	9
10	928	775	647	541	452	378	315	263	219	183	153	128	107	10
11	920	769	642	537	449	375	313	261	218	182	151	127	106	11
12	914	763	637	533	445	372	310	259	216	180	150	126	105	12
13	907	757	633	529	442	369	308	257	214	179	148	125	104	13
14	900	752	628	525	439	366	306	255	213	178	147	124	103	14
15	894	746	623	521	435	363	303	254	211	176	146	124	103	15
16	887	741	619	517	432	361	301	253	210	175	145	123	102	16
17	880	733	614	513	428	358	299	250	208	173	144	122	102	17
18	874	729	609	509	425	355	297	248	206	172	143	121	101	18
19	867	724	605	505	422	352	294	246	205	171	142	120	100	19
20	861	719	600	501	419	350	292	244	203	170	141	119	—	20
21	854	713	595	497	416	347	290	242	202	169	140	118	—	21
22	848	708	591	493	412	344	288	240	200	168	139	117	—	22
23	842	702	587	490	409	342	285	238	199	166	138	116	—	23
24	835	697	582	486	406	339	283	236	197	165	137	115	—	24
	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day	11th day	12th day	13th day	

Note—The first column of the table is a copy of Rutherford's figures published in 1912. The successive numbers can be obtained by multiplying by ·99253, which factor, therefore, represents the relative amount of emanation remaining at the end as compared with the quantity at the beginning of each hour.

The numbers in the first and last lines—the same numbers, as these represent the amounts remaining at the end of each day or the beginning of the next—are taken from Colwell and Russ (1915). The remaining numbers were calculated or averaged.

When the table was finished it was found that the numbers for the 14th, 16th, 18th, 20th, 24th, and 30th days also agreed with those of Colwell and Russ.

In each number the first two figures are, on the whole, accurate; the third is an approximation to the nearest whole number. The units figure is the cause of some apparent discrepancies, and reduplication of some numbers on the table. Thus the two consecutive 129 shown might represent 129·49 and 128·51, each an error of less than half per cent.

When using the table, the first or 0 hours line is always disregarded, as it is the same as the last or 24 hour line.

Some points in the table require consideration. From it, which may not be at first obvious, the hourly decrease of any quantity of radium emanation—that is after it has reached its maximum four hours after collection—can be read off for an indefinite period.

The table may be conveniently considered under headings marked I, II, &c.

I. Primarily the table shows the hourly decline in activity of 1,000 millicuries of radium emanation until in 12 days, 19 hours, there remains 100 millicuries, or 10 per cent. of the original amount present. The last column in the table has five blank spaces. These spaces may be filled legitimately by the five numbers in the one to five hour lines in the first column by the insertion of a decimal point, with one place of decimals. The activity of 1,000 millicuries in 12 days, 24 hours, *i.e.* at the end of the 12th day, or the beginning of the 13th day, is 96·3 millicuries. The successive columns in the fifth hour line, with one place of decimals, shows the activity at the end of the 13th to the end of the 25th day. Similarly the quantities remaining at the terminations of the 26th to the 38th days are found in the successive columns of the 10 hour line, with two decimal places, and of the 39th to the 51st days in the 15th hour line, with three decimal places, and so on. In fact, provided the 10 per cent. reduction takes place in exactly 12 days 19 hours, the table shows correctly that in a year 292×10^{-24} millicuries remain.

II. The table deals with 307 hours, and contains 301 different numbers. It is obvious that the hourly decrease of activity of the amount of emanation corresponding to any of these numbers—and also these numbers multiplied or divided by 10, and its powers by the addition of noughts or decimal points—may be read off directly from the table. It is immaterial, therefore, whether the maximum amount of emanation is 1,000, ·672, 2,610, or 116 millicuries, as all these numbers are represented on the table. Thus ·672 millicuries at the end of an hour will be ·667, and at the beginning of the ninth hour will be ·633 millicuries, while in 24 and 48 hours respectively there will be ·561 and ·468 millicuries, that is the figures on the same line but in succeeding columns.

Again, the hourly decrease of a maximum of 116 millicuries may be traced directly for 20 hours till it reaches 100 millicuries, and the quantity present at the end of the 21st hour is shown by dividing by 10 the number in the first hour line in the 0 day or the first day column, and is 99·3 millicuries. The amount at the end of the first and each succeeding day to the 13th is shown in the four hour line.

III. When a supply of emanation at the time of its maximum does not correspond to a number on the table, it is obvious that in less than an hour later the amount remaining will correspond to the next lower number. If it is assumed, which for practical purposes it may be, that during one hour emanation decreases at a uniform rate, and not exponentially, it is easy to calculate when the next number will be reached. If this time and number are substituted for the time of maximum and the amount supplied, the table may be used as before. Thus, a supply of emanation is received which reaches its maximum of 64·4 millicuries at 4.21 p.m. A reference to the table shows the numbers 647 and 642. Their difference, five, is the amount lost in an hour, or a unit is lost every 12 minutes. At 4.45 p.m., therefore, the activity of 64·4 millicuries will be 64·2, a number on the table from which its hourly decrease, reckoned from 4.45 p.m., may be traced. In effect, in order to co-ordinate a supply of emanation with the numbers on the table, it is sometimes necessary to compensate a slight loss of activity by a small gain in time.

IV. In using the table it is immaterial whether the activity of the emanation is estimated in millicuries, *i.e.* in equilibrium with Ra, radium element, or as being in equilibrium with a radium salt. As the relative activity of emanation measured by the various standards is constant, so the hourly decrease in activity will conform with the numbers on the table.

As has been pointed out on a previous occasion (1), in recording dosage it is a decided advantage to adhere to the millicurie and radium element standard as the most uniform, logical, and generally convenient standard of measurement. Emanation in equilibrium with the radium salts below may be reduced to millicuries, or *vice versa*, by employing the following formula:—

$$\frac{\mathrm{Ra}}{1} = \frac{\mathrm{RaSO_4}}{1{\cdot}424} = \frac{\mathrm{RaCl_2}}{1.315} = \frac{\mathrm{RaCl_2{\cdot}2H_2 0}}{1{\cdot}474} = \frac{\mathrm{RaBr_2}}{1{\cdot}723} = \frac{\mathrm{RaBr_2{\cdot}2H_2 0}}{1{\cdot}81} = \text{millicuries.}$$

V. Since the rise of activity of de-emanated radium is the complement of the loss of activity of the equilibrium amount of emanation for the same period, the amount of emanation formed from a given amount of radium in any given time may be found from the table by a simple subtraction. A radium salt in a sealed receptacle remains in emanation equilibrium because the same amount of emanation is formed as is lost in a given time. A radium salt showing an activity of 1,000 millicuries will, for practical purposes, show the same activity in an hour, a day, a week, or a year later, as the period of radium is 1,690 years. The emanation table, however, shows that 1,000 millicuries of emanation will lose in an hour 1,000 — 993 = 7 millicurries ; in a day, 1,000 — 835 = 165 millicuries ; in a week, 1,000 — 283 = 717 millicuries ; or to put it in another way, 1,000 milligrammes of radium metal will have to produce seven millicuries per hour, 165 millicuries per day, and 717 millicuries per week, in order to maintain emanation equilibrium, and register on the electroscope 1,000 millicuries. Therefore, to find the amount of emanation a given quantity of radium element or salt will collect in a given time, it is only necessary to subtract the amount of emanation left in that time, as shown in the table, from the amount of emanation in equilibrium with the radium or salt, also shown in the table. As about 10 per cent. of the quantity of emanation present is lost during the collection from a radium solution, when the amount of radium does not correspond to a number on the table, the next lower number is accurate enough for practical purposes, However, the theoretical quantity can be ascertained, as, for example, 92·6 milligrammes of radium in 4 days, 2 hours, will collect 92·0 + ·6 — 44·2 — ·288 = 48·112 millicuries of emanation.

VI. It is obvious that if a supply of emanation is not measured by the electroscope till some time after it reaches its maximum, the activity at its maximum can be easily ascertained from the table. Thus, if a supply of emanation shows an activity of 144 millicuries 20 hours after it is sealed off, it would have reached its maximum 16 hours before measurement, and the table shows that its activity at that time was 164 millicuries.

VII. For clinical work the table has great advantages. With it before him the operator is in a position on the spot to estimate, or subsequently to record the average quantity of emanation employed, and has not to await a suitable opportunity to calculate it out. He can ascertain at once the amount of ionization effected by a certain length of exposure, or the length of exposure required to effect a certain intensity of ionization, taking into account, of course, by how much ionization is reduced by the screen used. Briefly, it is much easier to find the activity of emanation by counting lines, *i.e.* hours, or columns, *i.e.* days, than by multiplying together a series of numbers. I have previously pointed out that the average amount of emanation employed during an exposure is approximately the amount of emanation present at half time in the exposure. For instance, 81·7 millicuries of emanation are buried in a tumour at 9 a.m. on the 1st January, for 16 hours, until, as shown in the table, the activity is reduced to 72·4 millicuries. If these two and the intermediate 15 numbers are added together and divided by 17, or the sum of the intermediate numbers divided by 15, the result, 76.9 millcuries, is the average activity of the emanation employed, and is the figure on the table showing the amount of emanation present at the end of the eighth hour after treatment is begun, or at half time in the treatment. Therefore, to find the average amount of emanation employed it is only necessary to count down half the number of hours in the exposure. If the exposure is for 17 hours, the quantity factor is the mean of the numbers at the eighth and ninth hours, in this case 76·6 millicuries. As before, these two exposures may be conveniently recorded as 76·9 × 16 = 1230·4 millicurie-hours, and 76·6 × 17 = 1302·2 mch., where the quantity factor and the time factor of a dose are put down in the order indicated by the term millicurie-hour, and their product in millicurie-hours indicate the total amount of ionization effected, having due regard for the effect of the screen used. If the same supply of emanation is buried at 11 a.m. on 2nd January, *i.e.*, one day two hours after its activity was 81·7 millicuries, the table shows its activity to be 67·2 millicuries; if this is left in for eight hours, the average dose is found four numbers down, and is 65·2 millicuries.

One error that is liable to occur in using the table is from miscounting the days and hours, which it is comparatively easy to do if pressed for time. To avoid this possible source of confusion, I have modified the table as shown in the next lantern slide, with an example filled in.

Eight Capillary Tubes of Radium Emanation.
Maximum Activity 65·15 millicuries.
At 4.49 p.m. 4th January, 1916.

1 hour before time of maximum 98 per cent. present.
1½ hours ,, ,, ,, 95 ,, ,,
2 ,, ,, ,, ,, 89 ,, ,,
2½ ,, ,, ,, ,, 76 ,, ,,
3 ,, ,, ,, ,, 54 ,, ,,
3½ ,, ,, ,, ,, 22 ,, ,,
4 ,, ,, ,, ,, 0 ,, ,,

Table Showing hourly decrease of Radium Emanation after reaching its Maximum.

DATE. TIME	*(Sat. 15/1/16.)*		*Tues. 4/1/16.*	*Wed. 5/1/16.*	*Thu. 6/1/16.*	*Fri. 7/1/16.*							*Fri. 14/1/16.*	TIME
(2.53 a.m.)	1000													
(3.53 a.m.)	993	829	692	578	482	403	336	281	235	196	164	136	114	*8.53 a.m.*
	985	823	687	573	479	400	334	279	233	194	162	135	113	
	978	817	682	569	475	397	332	277	231	192	161	134	112	
	970	811	677	565	471	394	329	275	230	191	160	133	111	*11.53 a.m.*
	963	805	672	561	468	391	327	273	228	190	159	132	111	
	956	799	667	557	465	389	325	271	226	188	157	131	110	*1.53 p.m.*
	949	793	662	553	462	386	322	269	225	187	156	130	109	
	942	787	657	549	458	383	319	267	223	186	155	129	108	
	935	781	652	545	455	380	317	265	221	184	154	129	108	
(12.53 p.m.)	928	775	647	541	452	378	315	263	219	183	153	128	107	*5.53 p.m.*
	920	769	642	537	449	375	313	261	218	182	151	127	106	
	914	763	637	533	445	372	310	259	216	180	150	126	105	
	907	757	633	529	442	369	308	257	214	179	148	125	104	
	900	752	628	525	439	366	306	255	213	178	147	124	103	
	894	746	623	521	435	363	303	254	211	176	146	124	103	
	887	741	619	517	432	361	301	253	210	175	145	123	102	*11.53 p.m.*
	880	733	614	513	428	358	299	250	208	173	144	122	102	*12.53 a.m.*
	874	729	609	509	425	355	297	248	206	172	143	121	101	
	867	724	605	505	422	352	294	246	205	171	142	120	100	*2.53 a.m.*
	861	719	600	501	419	350	292	244	203	170	141	119	—	
(11.53 p.m.)	854	713	595	497	416	347	290	242	202	169	140	118	—	
	848	708	591	493	412	344	288	240	200	168	139	117	—	
	842	702	587	490	409	342	285	238	199	166	138	116	—	
	835	697	582	486	406	339	283	236	197	165	137	115	—	*7.53 a.m.*
DATE.	*(Sun. 16/1/16.)*		*Wed. 5/1/16.*	*Thu. 6/1/16.*	*Fri. 7/1/16.*	*Sat. 8/1/16.*							*Sat. 15/1/16.*	

NOTE.—1. The line under 647 denotes that the record of the supply of radium emanation starts at that number, remembering that 64·7 is the actual activity in this case.

2. The hour 5.53 p.m. in the right hand time column is the time, calculated from the data supplied, at which the activity is 64·7.

3. The line from under 619 to the right divides the days, the date above the line being one day behind that below the line.

4. When the activity of the supply goes below 10 millicuries, the dates and the times in the right hand column are cancelled, and the dates—in brackets here for clearness—and the hours in the left hand column, also in brackets, are substituted. The later particulars should only be filled in when they become necessary.

5. If the dates and hours are filled in on the table as above, to ascertain the average amount of

emanation employed in an exposure, it is only necessary to read the figure on the table opposite the hour and date at which half the exposure is over. Thus, if the patient is treated about 9 a m. on the 7th January, for six hours, the average quantity of emanation used on him will be opposite 11.53 a.m. on that date, and is seen to be 39·4 millicuries.

In the revised table the numbers of days and hours are left blank, so that the dates and times corresponding to the supply of emanation may be filled in opposite their proper lines and columns. The numbers in the 0 hour line, except 1,000, are omitted, as they are the same as those in the 24 hour line, and are liable to be counted in mistake. The lantern slide also illustrates a form of leaflet which might with advantage be sent out with each supply of radium from a Radium Institute. If the time of the maximum activity and its measurement is recorded on this leaflet, the surgeon has all the particulars he requires for estimating his dose with the least labour to himself. It is convenient to have the table showing the rise of activity of radium emanation till the maximum is reached in four hours, as it is sometimes possible to obtain the supply before it reaches its maximum. By using it for about two hours before maximum the average activity is as great, or greater, than for two hours after that time.

In conclusion, I wish to express my indebtedness to Mr. Moss, Scientific Director of the Royal Dublin Society Radium Institute, for furnishing me with the printed copies of the table which you have before you.

REFERENCES.

(1) A Method of Recording Radium Doses.—*Archives of Radiology and Electrotherapy, January*, 1916.

REPORT OF A CALCULUS IN THE FOSSA NAVICULARIS URETHRÆ.

By Capt. J. D. Morgan, C.A.M.C., B.A. (Cantab.); M.D., C.M. (McGill, Montreal).
Radiographer Canadian General Hospital, British Expeditionary Force, France.

The patient (G. H.) was admitted to the hospital complaining of extreme pain during micturition.

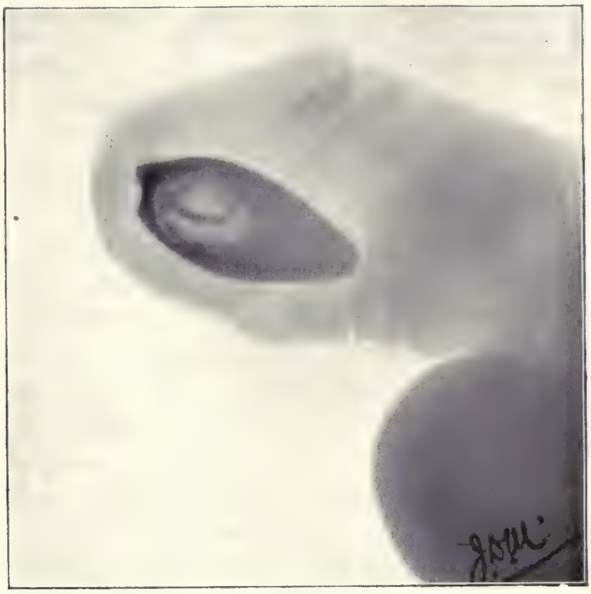
He is a bricklayer by trade, is a moderate drinker, and has always had good health.

Five days ago, while lifting a heavy weight, he felt an excruciating pain in the region of the bladder, and an extreme desire to micturate, which he did several hours later.

No blood was passed. Later on, micturition became extremely difficult and painful. About this time he discovered a hard, movable mass near the end of his penis. On pressing this back a little way up the urethra he was able to micturate with greater ease and with less pain.

On examination a firm mass could be felt in the urethra near the meatus, and on separating the lips the tip of a tan-coloured mass could be seen.

A skiagram was made which showed the mass to be a nucleated calculus about the size of an olive, situated about half an inch from the end of the urethra.



Under local anæsthesia this was removed in one piece.

I am indebted to Captain MacLeod for permission to report this case.

REPORTS OF SOCIETIES.

ROYAL SOCIETY OF MEDICINE. DERMATOLOGICAL SECTION.

MEETING held June 17th, 1915.

Dr. E. G. **GRAHAM LITTLE** showed a case of *Mycosis fungoides following upon X-ray treatment.* The patient was a lady, aged 25 years. For three years she had suffered from a scaly eruption of the limbs and trunk, rather more plentifully distributed on the flexor surfaces, which had been diagnosed as psoriasis by several general practitioners. Various treatments had been applied, including chrysarobin, but without permanent success. Itching had not been a marked feature prior to the application of X rays, which had apparently effected a remarkable change in the conditions. This treatment had been commenced in the middle of February of this year by a general practitioner in north London, who had given exposures over the whole surface of the body, in dosages which could not be ascertained, at intervals of a week or fortnight, the actual dates being February 16th and 23rd, March 9th and 23rd, April 6th, 20th, and 27th, May 4th, 11th, and 19th. During the course of this treatment, but not before it was undertaken, glandular enlargements in the axilla, on the trunk 3 in. below the axilla, in the neck and in the groin were noted. It was deemed advisable to apply extra doses to these swellings, but as they increased in size and a tumour appeared in the pubic region, the patient consulted Dr. Godfrey, under whose care she had been some time previous to the application of X rays, and the exhibitor saw the patient in consultation with Dr. Godfrey on May 26th, when the diagnosis of Mycosis fungoides was proposed.

At this date there was a tumour the size of a small walnut on the right side of the mons veneris, with unbroken surface, and another much smaller swelling, the size of a Barcelona nut, on the anterior wall of the left axilla. On the neck, the upper arms, the chest and abdomen, there were some circinate scaly patches, very reddened and infiltrated, and bearing signs of intense itching. The scalp was extremely scurfy all over. The face was puffy and red, and there was a general redness over the greater part of the body, which, as it had not been present before application of the X rays, was ascribed to this cause. The entire surface was tender, so that combing the hair, for example, was a painful operation, and the patient found difficulty in obtaining comfort in any posture, and her sleep was disturbed. She was seen again on June 15th, when all these symptoms were accentuated, and the tumour in the wall of the axilla had grown to the size of a tangerine orange, but was still unbroken; a new tumour which had reached the size of a walnut had made its appearance on the back of the neck, and there were some small new tumours elsewhere. The patient was menstruating and did not wish to show the pubic tumour, which it was reported was steadily growing larger. There was general enlargement of glands.

It was, of course, open to doubt the diagnosis of psoriasis, and it was, in fact, probable that the earlier manifestations of disease, which had been regarded as psoriatic, had been really premycotic stages of Mycosis fungoides. Howard Fox had, however, reported an instance of development of Mycosis fungoides in an undoubted psoriasis, so that the metamorphosis was not unprecedented. But the interest of this case was enhanced by the very definite history vouched for by a practitioner of great experience, Dr. Godfrey, that there had been no glandular or other swellings until the application of the rays, and it seemed significant that the tumours had in fact appeared in areas where additional dosages of the rays had been given. Under these circumstances, which were sufficiently disconcerting, the exhibitor had not thought it wise to recommend the continuance of X-ray treatment, which might otherwise be one's first resource in such a case.

The general consensus of opinion expressed at the recent debate on Mycosis fungoides seemed to be that X rays were palliative rather than curative of the disease; Galloway had voiced a very general opinion in his summing up: "Considerable doubts evidently remain as to the possibility of cure by means of X rays. There was no doubt that cases had recurred after the use of X rays. Possibly the safest line in X-ray treatment was to confine it to the destruction of the actual tumours as they appeared." In this case the greatest growth had been in parts treated with the rays, so that even the very limited use recommended by Galloway seemed undesirable.

The **President** did not think that, on the whole, the original diagnosis of psoriasis held good. Among other points, the lesions were almost entirely flexural in distribution, while the tips of the elbows and the knees were markedly unaffected. He was personally of the opinion that the early eruption was a so-called "pre-myosic" one. He invited an expression of opinion as to the *rôle* played by X rays in the production of the tumours, which he believed to be *nil*; and, arising out of that, the question occurred whether the continuation of treatment by X rays would be justifiable. The number of the tumours and the extensive erythrodermia seemed to him to contra-indicate operation. He would expressly exonerate the practitioner from any blame for using X rays in the case, and, indeed, he regarded such treatment as the only possible means of arresting or mitigating the severity of the disease.

Dr. **Sibley** said the wording of the title of the case gave the impression that Dr. Little considered the X rays to have been the cause of the Mycosis fungoides. He (the speaker) would suggest that the X rays were a coincidence and that the patient had had a premycotic dermatitis, for she said the rash had been very irritable for many months and was on the flexor surfaces: it had not been psoriasis. He did not consider she now had any evidence of X-ray dermatitis; the inflammation was fairly evenly distributed and never localised. He advised pushing doses of X rays to the tumour areas.

Dr. G. **Pernet** had no doubt as to the case being one of Mycosis fungoides. The fact that the tumours had developed after the application of X rays he regarded as an accidental circumstance, not as a sequence of cause and effect. It was evidently a virulent case, as the tumours were forming rapidly. He recommended pushing the rays as practically the only method of treatment. He did not recommend salvarsan, as it was not successful in a somewhat similar case of his own. He thought it would be a help first of all to remove the tumours surgically.

Dr. Dore said it was difficult to explain the apparent failure of the X rays unless one knew the details of the treatment. His view was that the tumours had appeared not because of, but in spite of the X rays; and he thought it would be a pity to withhold the most efficacious form of treatment known for this disease.

Dr. Sequeira agreed that this was a fortuitous outbreak; he did not regard it as connected with the application of the X-ray. He also recommended the pushing of X-ray treatment.

Dr. Adamson said he would continue the X-ray application as that treatment was the only one which offered any hope of a cure. But he thought it would be well to ascertain first of all what doses of rays had already been given.

Dr. Graham Little, in reply, thanked members for their views, but the impression was so strong in the mind of the patient that the rays were the cause of the tumours, that any untoward progress would be attributed to the rays; hence he did not feel inclined to follow the advice tendered.

NEW YORK ACADEMY OF MEDICINE. SECTION OF SURGERY.

Meeting held March 5th, 1915.

X-Ray Keratoses on Hand of Radiologist Cured by Radium.

Dr. Sinclair Tousey reported this case. He stated that his own hands had long been disfigured by growths which had resulted from his X-ray work. The lesions were of two types. A very few were raised, almost pedunculated, healthy looking fleshy tumours with a black pigmented apex. About thirty others were exceedingly hard black lumps projecting slightly above the surface of the skin. The smaller ones had a tendency to undergo spontaneous exfoliation about once a year, leaving a healed surface somewhat depressed but surrounded by an indurated base. In a very few days a deposit of pigmented granules would take place looking under the microscope, like particles of anthracite coal, and in a week or two the black lump would have been renewed. The smaller lumps of this kind could be curetted out at any time, leaving a dry reddish granular depression upon which a similar growth would be quickly reproduced. There were some larger ones which never came away spontaneously. Some of these were associated with deep painful fissures of the skin. For years the author kept these unsightly excrescences under some kind of control by the application of salicylic and lactic acids, which removed them temporarily. Another application which was not permanently successful was full strength formalin. About a year ago, at the suggestion of a general surgeon, two of the larger growths were treated with pyrogallic acid, one dram collodion, one ounce, applied three times a day. This application was not painful at first, but later produced terribly sore fingers with suppuration beneath the areas destroyed. Eventually the growth came away and the ulcer healed, but the growth returned in a short time, and all the suffering had been in vain. Dr. Caldwell had succeeded in curing certain X-ray lesions of his hands with radium, and the author determined to try it on his own hands. He selected one of the largest growths, which resembled a horn on the dorsum of the interphalangeal articulation of the left ring finger. The field of application was limited by a protective sheet metal rendered adhesive by coating it with double-faced adhesive plaster. Twenty milligrams of radium element, enclosed in a small glass tube covered with the thinnest soft rubber, was kept almost in contact with the skin for thirty minutes. The growth had previously been pared down almost to the bleeding point with a scalpel. The result of the application was not perceptible for about ten days, and then the skin became somewhat red and shiny. Twenty days further passed without any decided change. During this month the pared off keratosis had not sprung up again, as would have been the case had the radium not been applied. On the thirty-first day the reddened skin around its edges was discovered to be loosened from the underlying tissues, and in a few minutes the entire destroyed growth was frisked off like a scab. The surface beneath was pink and tender but fully healed, and now, ten weeks after the application of the radium, the skin was strong and presented no marks of any kind. He had been treating the other growths seriatim, and all came away in about a month, leaving a healthy surface beneath. Dr. Tousey presented the histological report from Dr. Sondern, who concluded with the statement that evidently X-ray keratoses, while in the precancerous state, were curable by radium applications. The double-coated adhesive plaster referred to was in regular use for different mechanical purposes. It consisted of cloth coated on the back with rubber adhesive plaster mass, and on the other side with zinc oxide plaster mass. For radium-therapy the back of the plaster was applied to a silver half-dollar or some other piece of metal serving as a handle or as a means of shielding the patient's fingers from the radiation, and the face of the plaster was fastened to the tube of radium with whatever covering was desirable to filter the radiation or prevent direct contact with the patient and contamination.

REVIEW.

The Röntgen Diagnosis of Surgical Lesions of the Gastro - Intestinal Tract. By ARIAL W. GEORGE, M.D. and RALPH D. LEONARD, A.B., M.D. The Colonial Medical Press, Boston. 1915. $10.

The authors of this important work have succeeded in raising the Röntgen Diagnosis of Lesions of the Gastro-Intestinal Tract to a very high level, and have produced a book which will take the place of a standard work of reference to the Physician, the Surgeon, and the Radiologist, on account of the many admirable illustrations of practically all the diseases of the Tract which are capable of demonstration by X rays.

A very valuable feature is the illustration of normal and abnormal conditions, each plate being accompanied by a key plate indicating the points in the X-ray diagnosis, and the operative findings are given in all cases which have been examined surgically. Much may be learned from a careful study of the excellent plates which form the greater part of the book.

The scheme of the book is good, the normal appearance of the organs being dealt with *in extenso*, and then the many departures from the normal. The text is surprisingly brief, —one could have wished to see a fuller description which could readily have been supplied by the authors from their very large experience of these diseases. We note the statement in the preface that no "retouching" has been done; this adds value to the excellence of the reproductions.

The Normal Stomach is fully dealt with in a short chapter, in which the authors call attention to the two schools of radio-diagnosis, namely, the Continental and the American. The former is distinguished as the pioneer of the indirect method, while to the American school is attributed the direct method. The authors leave no doubt in the minds of the readers as to which, in their opinion, is the more reliable method.

Exception must be taken to this somewhat arbitrary manner of dealing thus definitely with two schools which, after all, must number many members who practise one or other method, or more probably a combination of the two, while all credit is given to the many American Röntgenologists who have done so much to advance radiography to its present high position amongst diagnostic methods.

The technique employed by the authors is described in the opening chapters, and special points and modifications are referred to at the beginning of each section.

A variation in the method of preparing the meal is worthy of notice, a more fluid meal being used than that generally recommended by the majority of workers, though it is only fair to point out that several of the leading men in the so-called Continental School have advocated a fluid meal for the examination of some of the conditions met with.

The apparatus used is not described in detail.

The first section of the text ends with a description of the normal stomach. This section is illustrated by 35 plates of the normal organ in its many variations.

Section II deals with Gastric Ulcer in all its modifications.

The authors use a meal consisting of 2 ozs. of bismuth subcarbonate to two glasses of buttermilk given on an empty stomach.

The Röntgenoscope is used, but reliance is placed upon the findings disclosed by the serial plate, and the reasons for such reliance are given. With this we are in entire accord. Two positions of the patient are employed :—

(1) Standing with the abdomen against the plate.

(2) The prone position.

Lateral plates are also taken in a number of cases.

The section deals with superficial Ulcer, Chronic Penetrating Ulcer, Hour-glass Deformity, and Pyloric Obstruction. The illustrations in this section leave nothing to be desired, and form a most convincing argument in favour of this method of examination.

Section III deals with the important subject of Gastric New Growth ; a careful perusal of the text and the numerous illustrations in this section will amply repay the reader.

Section IV. Ulcer of the Duodenum.

This section opens with an appreciation of the work of Moynihan Patterson, William Mayo, and of the Radiographic work of Cole, of New York. The value of X-ray diagnosis in Duodenal Ulcer is fully discussed, many interesting points in technique are dealt with, and the illustrations in this section are very convincing.

The Gall Bladder.—The section on the gall bladder is very comprehensive, and a number of good plates are shown. The statement is made that 50 to 75 per cent. of gall-stones will show ; this is given as a result of the general experience of Röntgenologists who have devoted themselves to the development of a good technique. The authors state that with their technique 85 to 90 per cent. can be demonstrated. The technique is not radically different from that employed for soft tissue work in any other part of the body.

The Small Intestine is briefly dealt with in the text. Ileal Stasis is discussed, as is also the diagnosis of this condition. The section ends with a few lines on the differential diagnosis in cases of adhesions and new growths. Several interesting plates showing the Jejunum filled with opaque food are reproduced, one in particular is very instructive and striking, Fig. 221.

The Appendix receives a full description, a large number of departures from the normal being illustrated. An important point is noted in relation to the constitution of the opaque meal. It is suggested that buttermilk is a more favourable vehicle for the suspension of the barium, as it is more likely to pass into the appendix. Probably the fermented milk reaches the cæcum in a more fluid condition. The six and the twenty-four hour plates are the ones most likely to show the opaque food in the appendix.

Section VIII deals with the Large Intestine.

Here the technique includes the opaque meal and the opaque enema. A large number of anomalies in the colon are illustrated. An interesting case is one of Hirschsprung's Disease of congenital origin occurring in a child of four years. Intestinal New Growth is also fully illustrated.

The book ends with a brief description of the important subject, "Diverticulitis of the Colon." The pathology is explained and a coloured plate illustrates the appearances seen when the bowel is removed. A number of plates are shown to illustrate the condition.

In conclusion, this book, really an atlas, is without doubt a production of the highést possible value, and must prove itself to be indispensable to the Physician, the Surgeon, and to the X-ray Expert. The latter will find it full of instructive points in technique, and, what is of greater importance, full of valuable illustrations of conditions upon which he is asked to pronounce an opinion.

The general arrangement of the book, and the high standard of the illustrations, reflect the greatest possible credit upon the publishers, and the careful collection of such a number of valuable clinical cases offers eloquent testimony to the vigour and enthusiasm of the authors. The book should find its way into the libraries of all practising medical men as a reliable reference work.

NEW INSTRUMENT.

A SIMPLIFICATION IN THE MACKENZIE DAVIDSON METHOD OF EYE LOCALIZATION.

By H. Trevelyan George, M.A. (Cantab.), M.R.C.S., L.R.C.P.

Clinical Assistant X-ray Department, St. Bartholomew's Hospital. Fellow of the Physical Society.

The only merit of this article lies in the fact that it helps to economize one's time in localizing foreign bodies in the eye by the Mackenzie Davidson method. It does not refer to the *taking* of the X-ray photographs, but to the subsequent proceeding of determining the exact position of the foreign body.

Everyone who has localized foreign bodies in the eye will know that it requires considerable concentration of mind if one is to arrive at a correct determination of the position of the foreign body. In changing from measurements made in relation to one point of reference to those made in relation to another, viz., from the cross of the wires to the upper end of the pointer fixed to the lower eyelid, and then from the latter to the central point of the anterior surface of the cornea, one is very liable to make mistakes unless one's whole attention is given to the subject, and one is free from interruption; such ideal surroundings are not always available.

The method described below gets rid of almost all of this difficulty; after once mastering the method, it eliminates most of the thinking required and makes the operation much more mechanical, with a corresponding increase in accuracy of result. It also saves much time.

We will suppose that we have placed on the Mackenzie Davidson localizing apparatus the celluloid sheet marked out in the usual manner with the cross and with the two positions of the foreign body, and of the tip of the pointer attached to the lower eyelid. Proceeding in the usual way, we first arrange the threads in respect to the two images of the *pointer*; let "a" be the vertical height of the intersection of the threads from the glass plate of the localizing apparatus. "a" is then of course the distance, measured internally, of the pointer from the plane of the cross wires used in taking the photographs. Next, let the point P in the figure represent the projection of the point of intersection of the threads on to the celluloid sheet, and let b and c be the lengths of the two perpendiculars PQ and PR respectively. We employ the convention that distances measured internally, superiorly, or anteriorly (using these terms in their usual anatomical sense in regard to the region of the head under consideration), are positive, while distances measured in the opposite

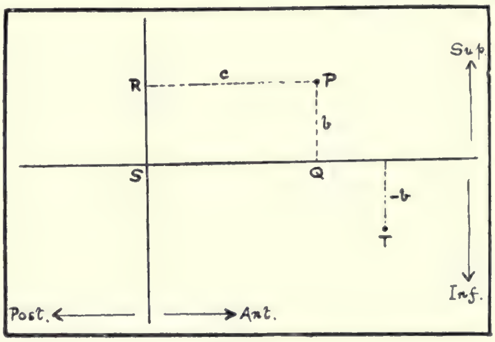


FIG. 1.

directions, viz., externally, inferiorly, and posteriorly are negative.

Note that in the figure, b is positive, being a distance measured *superiorly* from the horizontal line SQ. If the point P were below SQ, *e.g.* at T, b would become -b. Similarly, c denotes a distance measured anteriorly from RS. This convention, viz., that the positive directions are internal, superior, and anterior, must be strictly adhered to throughout.

We can now abbreviate the above as follows :—

Let tip of *Pointer* (in reference to *Cross* of wires) be :—

$$\left.\begin{aligned}\text{Internal} &= a\\ \text{Superior} &= b\\ \text{Anterior} &= c\end{aligned}\right\}\ \cdots\cdots\ (1)$$

a, b, and c can of course be measured in any units, but it is hardly necessary to say that the same unit must be employed throughout the determination.

We next arrange the cross threads for the images of the *foreign body*, and abbreviate the result in a similar way, thus :—

Let *Foreign Body* (in reference to *Cross* of wires) be :—

$$\left.\begin{aligned}\text{Internal} &= d\\ \text{Superior} &= e\\ \text{Anterior} &= f\end{aligned}\right\}\ \cdots\cdots\ (2)$$

Lastly, we will have made the following measurements on the patient before he leaves the table.

Let *Centre* of *Cornea* (in reference to tip of *Pointer*) be :—

$$\left.\begin{aligned}\text{Internal} &= g\\ \text{Superior} &= h\\ \text{Anterior} &= i\end{aligned}\right\}\ \cdots\cdots\ (3)$$

Then, from (1) and (2) we eliminate the cross of wires as a point of reference, and obtain by subtraction :—

Foreign body (in reference to tip of *Pointer*, is :—

$$\left.\begin{aligned}\text{Internal} &= (d\text{-}a)\\ \text{Superior} &= (e\text{-}b)\\ \text{Anterior} &= (f\text{-}c)\end{aligned}\right\}\ \cdots\cdots\ (4)$$

Finally, we eliminate the pointer as a point of reference, and obtain from (3) and (4) by subtraction :—

Foreign body (in reference to *Centre* of *Cornea*) is :—

$$\left.\begin{aligned}\text{Internal} &= (d\text{-}a\text{-}g)\\ \text{Superior} &= (e\text{-}b\text{-}h)\\ \text{Anterior} &= (f\text{-}c\text{-}i)\end{aligned}\right\}\ \cdots\cdots\ (5)$$

The preceding is the theoretical reasoning, but practically all that is necessary is to remember (or have before one) the meanings of the letters a, b, c, etc., and the final result given by equation (5).

In practice we make a chart as follows :—

	Pointer in ref. to Cross.	Foreign Body in ref. to Cross.	Centre of Cornea in ref. to Pointer.	Foreign Body in ref. to Centre of Cornea.
Internal	a =	d =	g =	(d-a-g) =
Superior	b =	e =	h =	(e-b-h) =
Anterior	c =	f =	i =	(f-c-i) =

As the measurements are made on the localizing table, they are entered directly in the chart opposite to a, b, c, etc., taking care to place the proper sign, *i.e.*, plus or minus, before the respective numbers, according to the convention mentioned. A simple calculation, viz., the determination of the values of (d-a-g), (e-b-h), and (f-c-i), immediately gives us the figures which we require for determining the position of the foreign body in reference to the centre of the cornea.

From these figures we can at once plot out, on the usual pictorial eye chart, the actual position of the foreign body inside or outside the eyeball.

The following is an actual example, and shows the method of manipulating the plus and minus signs :—

The tip of *Pointer* was $43\frac{1}{2}$ mm. internal, 3 mm. superior, and 51 mm anterior to the *Cross* of wires ... ... (6)

The *Foreign body* was 43 mm. internal, 9 mm. superior, and 47 mm. anterior to the *Cross* of wires ... ... (7)

The *Centre* of *Cornea* was 4 mm. external, 10 mm. superior, and 2 mm. anterior, to the *Pointer* ... ... (8)

From (6), $a = 43\frac{1}{2}$, $b = 3$, and $c = 51$.

From (7), $d = 43$, $e = 9$, and $f = 47$.

From (8), $g = -4$, $h = 10$, and $i = 2$.

Note the minus sign before the 4 ; by our convention the external direction is negative.

The chart is filled in and completed as follows :—

	Pointer in ref. to Cross.	Foreign Body in ref. to Cross.	Centre of Cornea in ref. to Pointer.	Foreign Body in reference to Centre of Cornea.
Internal	a = 43½	d = 43	g = -4	(d-a-g)=[43-43½—(-4)]=(43-43½+4)=+3½
Superior	b = 3	e = 9	h = 10	(e-b-h = (9-3-10) = —4
Anterior	c = 51	f = 47	i = 2	(f-c-i) = (47-51-2) = —6

The result shows that the foreign body is 3½ mm. internal, 4 mm. inferior (which is the same as — 4 mm. superior), and 6 mm. posterior (which is the same as — 6 mm. anterior) to the centre of the anterior surface of the cornea.

By plotting out these figures on the pictorial eye chart in the usual manner, we finally arrive at the actual position of the foreign body within (as in this particular case) or without the eyeball.

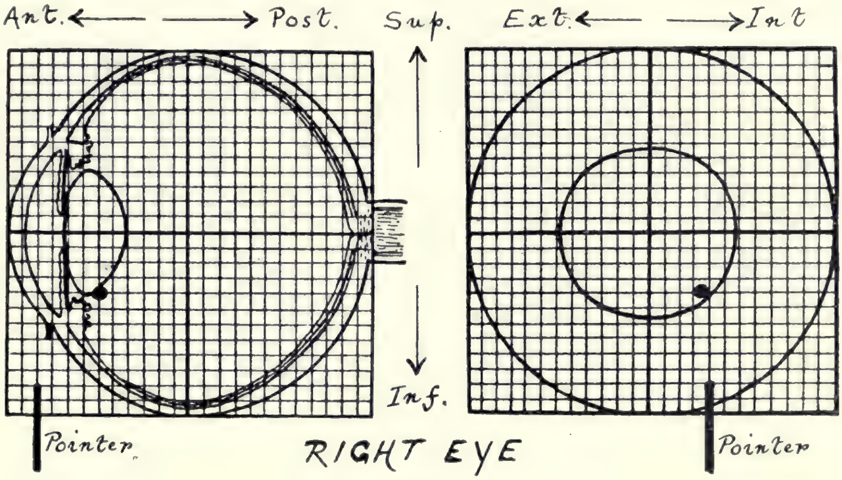


FIG. 2.

The above example has been described at length; in practice, of course, one would fill in the chart directly from the measurements made on the localizing apparatus, an operation which would only take a short time.

The chart also serves as a convenient and compact summary of the localization for future reference. If the skeleton chart be printed on the back of the pictorial eye chart, and two spaces added, one for the distance of the anticathode from the plane of the cross wires, and the other for the distance through which the X-ray tube was moved, we then have on one sheet of paper, in an exceedingly compact form, the whole of the data and results in connection with the localization.

For those who wish to memorize the chart permanently (which is much easier than would appear at first sight), so as to be able to reproduce it at any time, the following hints may be useful:—

(1) The order of directions in the first column is given by the "word" ISA.

(2) The order of the phrases "Pointer to Cross" and "Foreign Body to Cross" are easily remembered, but note that the position of the centre of the cornea is taken in reference to that of the pointer, and not *vice versa*, as would seem more natural. This order has been chosen, after due consideration, so as to make the number of minus terms as small as possible.

(3) The letters a, b, c, etc., naturally fall in their alphabetical order.

(4) The (d-a-g) is remembered as the "word" DAG, and it will be noticed that the letters below these three letters are, in the *vertical*

direction, in the usual alphabetical order, viz., d e f, a b c, and g h i.

The description of the method is necessarily rather long, but the whole thing becomes perfectly plain and easy after one, or at most two, actual examples have been worked out.

The writer uses this method for eye-localization work at St. Bartholomew's Hospital, and its use has saved much time, not to mention temper.

NOTES AND ABSTRACTS.

RADIOGRAPHY.

Some examples of the importance of the radiological examination of the inferior surface of the Liver.—By Dr. R. Ledoux-Lebard (*Journal de Radiologie et d'Electrologie*). — While the examination of all parts of the digestive tract proper has benefited greatly by the extension and perfecting of radio-diagnostic procedures the adjacent organs have remained rather outside the influence of this wave of progress. There would even seem to be indicated a slight movement of recoil as far as the inferior surface of the liver and the bile ducts are concerned.

Those physicians who expected to see radiography supply them with positive information as to the presence of gall-stones or as to the hepatic origin of a malady, deceived by constant negative reports, came to the conclusion that the radiological examination could throw no light on such cases, and was therefore useless. Nevertheless, leaving entirely on one side the superior surface of the liver, so well defined by the transparency of the lung substance, and adhering strictly to the lower surface and the bile ducts, one is soon convinced by an impartial study of published facts and a systematic examination of liver diseases, of the importance of radio-diagnosis and of the very precise information which radioscopy and radiography, carried out perseveringly and in accordance with a well thought out technique, can supply.

It is necessary to insist on the point of technique, for it plays a very important part.

It is well in the first place to try to establish clearly the hepatic margin by gas differentiation which insufflation of the colon, carried out under control by radioscopy, renders possible in an ideal manner, with no danger and with much less discomfort to the patient than is caused by the similar distention of the stomach.

It is then necessary to take plates in at least three positions:—(1) In the ventral decubitus—a plate of the entire region. (2) In the dorsal decubitus—a plate of the gall bladder region taken in accordance with the technique for kidney examination. (3) In the vertical position—the examination being completed by a screen and plate examination of the stomach region after the ingestion of a bismuth meal.

It is surprising what definite information such an examination will yield, and enables us to understand how the American investigators who follow this procedure, such as Case, can present a series of radiographs of gall stones which seems at first sight surprising, and boldly proclaim the necessity of hepatic radiographs. It must be admitted that these examinations are long and tedious, but it is better, in our opinion, not to undertake the radiological examination of the liver at all, than to carry it out in a perfunctory manner and without a good technique.

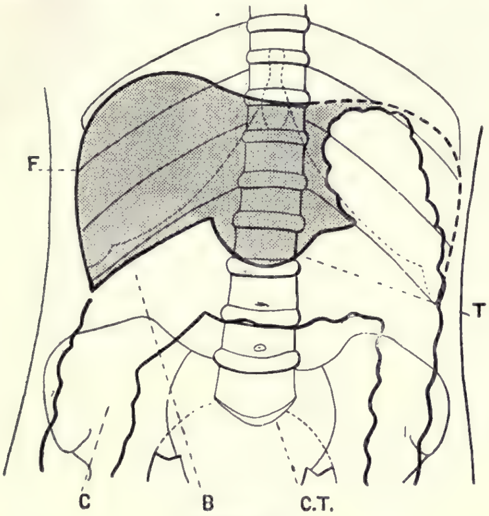
It is hardly necessary to add that it is best to use an installation powerful enough to permit always of instantaneous radiographs. Like Case, we recommend the use of soft rays of about 5B.

From the clinical point of view there are three questions which the radiologist is most frequently asked:—

(I) He is asked to diagnose if there is hepatic disease, and especially if, in the case of a palpable tumour in the abdomen, this is of hepatic origin. The following case taken from among three similar ones is an example of this, and shows that it is often possible to give a categorical answer to this question:—

(*a*) Madame V., aged 47 years, a highly nervous woman, with no special antecedent history, thought she had a small swelling in the epigastric region, which several surgeons whom she consulted declared to be imaginary. Her doctor, however, thinking he did feel a tumour, took her to M. A. Gosset, who asked us to make a radiological examination of the liver and stomach. After insufflation of the colon, radioscopy showed a rounded tumour, the size of an apple, on the anterior margin of the liver in a line with the vertebral column.

Schema (1) was drawn from a radiograph taken in the course of the examination. Our diagnosis was "a tumour on the lower surface of the liver, having the characteristics of a cyst." Operation (Dr. Gosset) showed a hydatid cyst, corresponding in size, shape, and situation to the shadow observed.



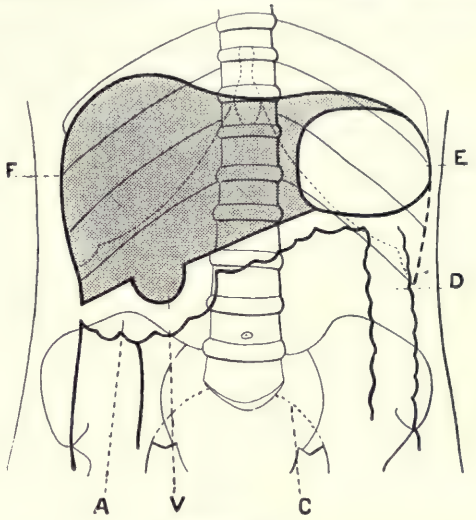
SCHEMA 1.*

(II) The radiologist is often asked to determine whether there is any disease of the gall bladder or not.

The positive verification of the shadow o the gall bladder, if it is possible to obtain it, will enable him to give an affirmative answer. In the interpretation of the shadows it must not be forgotten that the right kidney sometimes shows up with great clearness even in radiographs taken in the ventral decubitus with the plate under the abdomen.

(*b*) Madame N., aged 39 years, had attacks of pain closely simulating those of gall bladder origin. Nevertheless, before operating, Dr. Reymond wished to be satisfied that the condition was one of the gall bladder and not of the kidney. On radioscopy a shadow could clearly be perceived which seemed to correspond to the gall bladder, and in concurrence with Dr. Enriquez, who was present at the examination, we had no hesitation in interpreting it as such.

The radiograph gave the shadow reproduced in Schema (2). The stomach examination indicated a condition of adhesive pericholecystitis. Operation demonstrated a gall bladder filled with pus, with very thickened and sclerosed walls. The bladder contained a stone and was everywhere adherent.



SCHEMA 2.*

(*c*) A lady of about fifty years had suffered for a long time from pain in the right side. An indefinite mass could be felt which might be either gall bladder or kidney. The radiograph reproduced, in Fig. 3 of plate 9, shows the liver, the kidney prolapsed and increased in size, and a mass

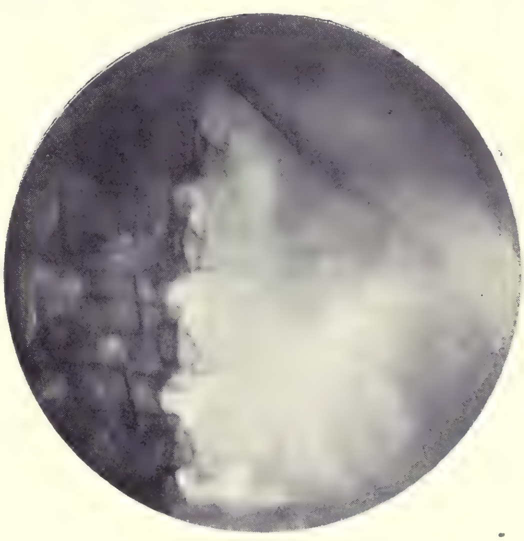


FIG. 3.*

which could only be the gall bladder, a hypothesis which operation confirmed, demonstrating to M. Gosset a hydro-cholecystitis, with a degenerated stone, the presence of which was suspected rather than seen on the plate.

(III) Are there any gall stones? This is certainly the question most frequently put to the radiologist in regard to the liver.

The report of Messieurs Desternes and Baudin on this subject, published in the *Journal*, gives all the indications of general use, and we will not dwell further on it. We will merely recall the fact that Case showed at the Congress in London, in 1913, a series of forty radiographs of gall stones collected in the course of 1,000 hepatic examinations.

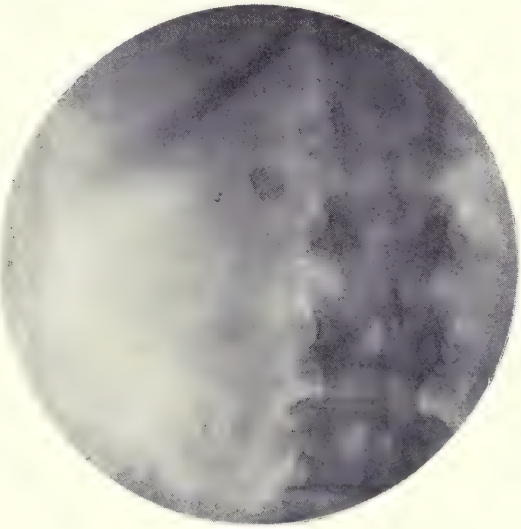


Fig. 1.*

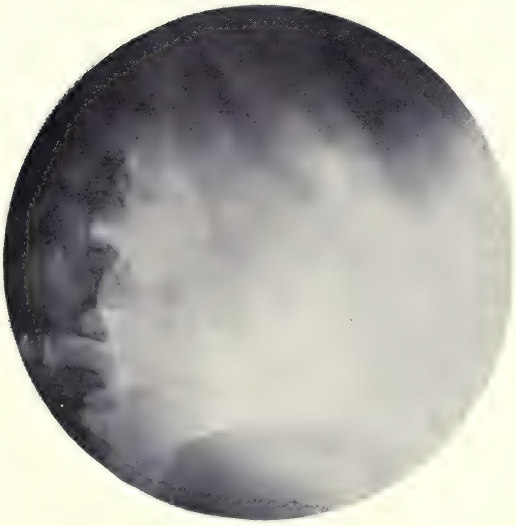


Fig. 2.*

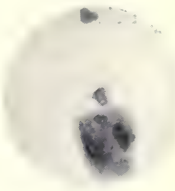
Now since October, 1914, we have ourselves met in forty-seven patients, radiographed from this point of view, four cases where gall stones were diagnosed with certainty, and one doubtful case. Our statistics, therefore, would seem to be not inferior to those of Case, which demonstrates clearly that the question is one of technique alone, and not of a chemical composition peculiar to transatlantic gall-stones.

(*d*) Madame S., 44 years of age. Had many hepatic crises—jaundice present. Radiograph in the abdominal decubitis showed a shadow resembling a stone situated between the two first right transverse processes. This shadow is clearly shown (Fig. 1, plate 9). Fig. 2 shows a radiograph of the same patient, taken with the usual kidney technique. In it is seen much more clearly the liver, shown at the level of the top of the right kidney, small and atrophied, and the characteristic quadrilateral shadow less dense in the centre, which evidently corresponds to a gall-stone with a calcareous coating.

Operation enabled M. Gosset to remove a single gall-stone which was very fragile, and which broke under examination, but which we reproduce nevertheless in the central fig. of plate 9, the radiograph being taken of the collected fragments after removal.

(*e*) Fig. 4, plate 9, shows a gall bladder full of stones. The plate was taken with the usual kidney technique. The patient was a lady who had had repeated attacks of gall stone colic, extending over many years. We believe therefore that it is necessary to carry out more often than is usually done the radiological investigation for gall-stones, which, with a good technique, will give us a little oftener perhaps than is thought proof of their presence, and in many other cases will enable us to make interesting verifications.

We reproduce here Fig. 5, the radiograph of a giant stone, a true cast of a large gall-stone, removed by M. Gosset. It would have been interesting to radiograph the patient before operation.



In cases which occur fairly often, where there is clinically some doubt between the gastric and the gall bladder origin of the symptoms observed, the doctor can ask the radiologist to examine and determine a doubtful diagnosis. Sometimes this will reveal a lithiasis which had been very doubtful, as happened to us recently in the case of a young girl, who presented very grave symptoms which might have been either gastric or duodenal in origin; this case will be published separately with radiographs, and in which we verified numerous stones in the gall bladder.

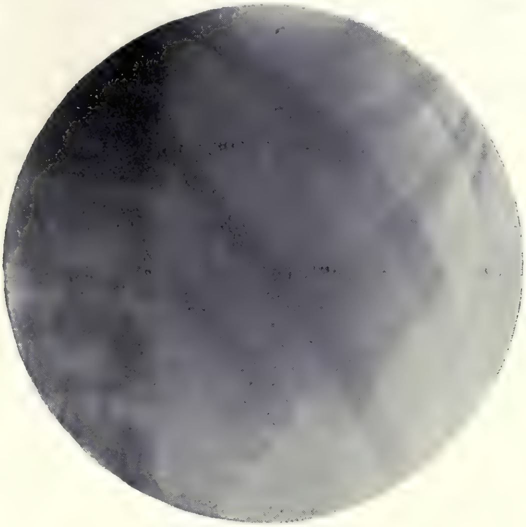


FIG. 4.*

In other cases, on the contrary, the examination may show a gastric or intestinal origin for the observed symptoms, while it must not be forgotten how difficult interpretation may be in the absence of characteristic shadows.

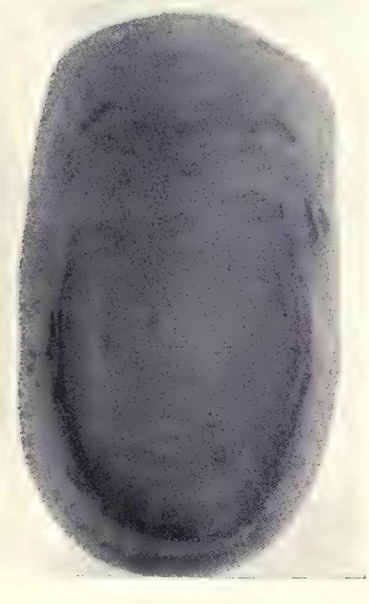


FIG. 5.*

These few illustrations, taken from among our cases of radiological examinations of the inferior surface of the liver, seem to us, in spite of their small number, sufficient to prove the usefulness of the examination, and compel us to urge that it should be carried out more systematically and in accordance with a suitable technique.

* *Reproduced by kind permission of Messrs. Masson et Cie, Paris.*

PHOTOGRAPHY.

New Method for the Rapid Drying of Negatives.—A. L. LUMIÈRE AND A. SEYEWETZ (*Penrose Annual*).—It is sometimes useful to be able to dry a negative within the shortest possible time, and the most effective method of accomplishing this has hitherto been the treatment of the negative by concentrated alcohol or acetone. This method, however, does not allow of complete drying of the negative after a single immersion, at least two successive operations being necessary. It is also costly, and involves the use of a product which is not only inflammable, but has the additional disadvantage of sometimes rendering the gelatine of the plate opaque, especially if the latter has not been completely freed from hyposulphite of soda.

We have found that certain salts, readily soluble in water, and without any disorganizing action on the gelatine, may be used in concentrated aqueous solution for the rapid dehydration and drying of water-soaked gelatine.

The desired result may be effected in a more or less thorough manner, by means of certain sulphates, sulphite and hyposulphite of soda, and carbonate of soda and of potash.

Among sulphates, sulphate of alumina (in 100 per cent. solution) produces the most complete dehydration. Sulphate of ammonia (in 75 per cent. solution), anhydrous sulphate of soda (in 50 per cent. solution), sulphate of zinc (in 160 per cent. solution), and hyposulphite of soda (100 per cent. solution), whilst acting to a certain extent, are less effective than sulphate of alumina.

Carbonate of potash in saturated (cold) solution (90 grammes in 100 c.c. of water) gave the best results in our hands, in regard to rapid drying of negatives, at the same time causing absolutely no alteration of the gelatine even after prolonged contact. The negative, soaked in water, is immersed for four or five minutes in the saturated aqueous solution of potassium carbonate, then briefly pressed between blotting paper to remove the greater part of the alkaline solution. Drying is completed by wiping the gelatine coating with a linen cloth. Rubbing will not harm the coating, which will have become very firm, and will assume a glossy appearance.

A negative so dried is ready for printing from, as the surface is quite dry and resists even pressure of the finger nail.

Carbonate of potash has the advantage over the other above-mentioned saline solutions of providing rapid and complete dehydration. Furthermore, all other salts cause white spots to appear, after a short time, on the surface of the plate, these being due doubtless to saline efflorescence. With carbonate of potash the coating suitably dried remains perfectly brilliant and transparent even after several weeks.

Nevertheless, certain negatives so treated develop defects in course of time, and for this reason we recommend drying by carbonate of potash only as a rapid temporary method. The negative can, of course, always be subsequently washed in water and dried by air in the ordinary way, the gelatine having undergone no permanent change by the drying treatment.

Experimental tests show that after treatment by carbonate of potash, desiccation is practically complete, only a very small quantity of water and carbonate remaining, and this does not affect printing.

To sum up, a saturated aqueous solution of potassium carbonate constitutes a new and economical method for the rapid drying of negatives, and possesses decided advantages over alcohol; it will therefore be of practical service in all cases where it is desired to use a negative as soon as possible after development.

The Wider Limits of Developers.—By T. THORNE BAKER (*Penrose Annual).*—Perhaps never until the outbreak of war with Germany did photographers realize what a versatile thing a developer is. We have become so accustomed to consider that certain developing agents are desirable for certain classes of work that when faced with the difficulty of obtaining future supplies of German-made reducing agents a certain amount of mild consternation was caused.

I think that this little trouble is having a wholesome educational influence, for many professional photographers are discovering that by studying the characteristics of a developing agent they *can* get, it is possible to produce with it the results they thought hitherto could be only produced with an agent they now *cannot* get.

Hydroquinone and caustic soda has been for many years used for dry plate process work, just as glycin has stood pre-eminent for stand development, and metol-hydroquinone for gaslight papers; but in no case is the reducing agent incapable of substitution, and in practically all cases the substitute can be made to give a result *just as good.*

It may be of interest to discuss briefly in this article a simple and systematic method of testing the capabilities of any reducing agent, and by so doing it will in general be found that without having recourse to different agents we can get with one only a sufficient variation in its action to meet all our requirements. The photo-mechanical worker has usually a good deal of different work to do as regards development, from the counteracting of the tendency in many orthochromatic plates to give harsh results to the production of harsh contrasts in half-tone and line negatives.

There could hardly be a more illuminating agent to take for an example than paramidophenol, as this base is the foundation or starting point of an immense number of developing agents. Benzol, C_6H_6, is converted into phenol, C_6H_5OH, and this successively becomes paranitrophenol, $C_6H_4OH.NO_2$, and paramidophenol, $C_6H_4OH.NH_2$. Modern chemistry has evolved derivatives of this base, many of which are patented, for each of which some individual and remarkable qualities are claimed, but the fact remains that if we carefully analyse the capabilities of the paramidophenol itself, it is found, alone, to equal practically any other reducing agent for photographic work.

In any case the routine of testing its powers is the same, *i.e.*, by using the reducing agent in solutions of various concentrations and with different proportions of accelerator and restrainer, and making test negatives in each case for comparison, we shall be able to determine what degrees of contrast and differences of gradation it is possible to obtain.

The test formulæ may be conveniently taken as follows:—

A.	Reducing agent	2 parts
	Potassium metabisulphite ...	1 ,,
	Water	100 ,,
B.	Anhydrous sodium carbonate ...	4 ,,
	Water	100 ,,
C.	Ten per cent. solution of potassium bromide.	

It is always desirable to test a developer in the first instance *without* bromide, and in most cases equal parts of A and B will give a good all-round developer,—perhaps a little concentrated, but this is a fault easily counteracted by dilution with water.

One of the most convenient, as well as the most suitable, pieces of apparatus for testing work is the Chapman Jones plate-tester, which gives for qualitative purposes almost as much information as the Hurter and Driffield slip. A modified form of the Chapman Jones tester—without the colour patches—is obtainable at a very much lower price, and this will be found an admirable form of densitometer for investigating both plates and developers.

The suggested procedure is to make equal exposures to a standard source of illumination at, of course, a fixed distance with the plate tester, and to develop one plate with equal parts of A and B, without bromide, another with the same solution with bromide, and others with larger relative amounts of accelerator, keeping up development in each case until, say, the twentieth or twenty-fifth square just shows up. By testing a sufficient number of variations of the developer, and comparing the negatives obtained, and by modifying the formula as the tests dictate, it will be found that a satisfactory developing solution for either direct copying or process work can be arrived at with practically any of the better-known reducing agents.

Where a plate-tester of some approved pattern is not available, a satisfactory analysis of the powers of a reducing agent can usually be made by exposing plates under a well-selected negative, but some form of densitometer is far preferable.

The moral is that where we cannot obtain further supplies for the time being of any one particular developer, there are others to be found "just as good."

CORRESPONDENCE.

THE HISTORY OF OUR PRESENT RESTING PLACE.

To the Editors of the Archives of Radiology and Electrotherapy.

Sirs,—The history of our present ground is not to be found in guide books, nor "Peeps into Picardy." There is an old man who lives near by who was porter for 41 years on our present ground, and from him one can learn interesting details. He is one of those old faithful servants who survives when the old order passes away. He remembers when our Hospital was nothing but fields and an Estaminet—or rather "une Guinguette" stood beyond the Porte de la Ferme (*i.e.*, the Northern Gate), with a walled garden behind it. The wall of the garden now encloses the former kitchen garden of the Jesuits, and the original Estaminet is the men's sleeping quarters. This property, named "Marlborough," at that time belonged to a rich Bourgeois known as the Capitaine de Capicure.

In 1874 the Jesuit Fathers bought the place and the fields around, and Pere Couplet founded and named it "Ecole libre Notre Dame"; at the same time the north wing was built. The school commenced on the 10th October, 1878. The foundations of the south wing (most of which is now destroyed) were laid in 1876, and the building was completed in 1878. The wall all round the grounds was built at the same time, money being borrowed for the purpose to the extent of one million francs.

The ruins now remaining included among other buildings, a beautiful chapel with fine paintings, carvings, statuary, and stained glass windows. These decorations and improvements were carried out from 1894 onwards by Pere Coetlosquet. The Grotto, which stands in a clump of trees looking old enough to be a Roman remains, was put up by him 20 years ago. In the upper part of it was a beautiful statue of the Virgin, but this, along with all the other statuary, paintings and carvings have been carried off, and now repose in the Ecole de Notre Dame at Le Touquet, a suburb of Mouscron in Belgium. About 300 boarders and 100 outside pupils studied at the Ecole, and evidences of the good times they had can be seen from photographs of the Salle de Fetes, which now forms our largest ward. It was then fitted up as a theatre, with massive curtains, and a background showing Boulogne in the distance. In the summer time, they had pageants and tableau vivant out-of-doors on a large scale, with elaborate costumes and scores of actors, chariot races, and sports of all kinds. All this passed away in 1902 when the Law of Separation came in. The State took over the school and the Fathers left the place. The famous Pere du Coetlosquet is now at work in Madagascar, but the old pupils still meet once a year in the Salle de Fetes to commemorate the glory of former days. The school continued under a layman for five years, the glory of former days having departed. In 1907 the fire took place, and since then demolition has gone on till to-day a few walls and a heap of rubbish remain.

The place was insured for 2,000,000 francs; the State took half, and the other half was used to pay off the debt on the buildings. Since 1902 it was used as a State school, but since 1907 it has been practically empty till our predecessors occupied it.

After the fire the Government sold the place, and the Old Pupils' Society bought Marlborough. A speculator bought the rest. Orphans occupied Marlborough during August and September, before the Indians came.

Such is the story that the old porter has to tell, and if you will sit and listen to him he will talk for hours about the old place and show you photographs of it at all stages of its growth, bloom and decay. It was a sad day for him when he had to leave the old place, and his last wish is that he may be buried near it—if not in it.

CAPTAIN A. HOWARD PIRIE,
No. 3 Canadian General Hospital—McGill.

January 13th, 1916.

NOTICES.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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THE FUTURE OF RADIOLOGY.

The direct recognition of the unqualified radiologist by hospital and other authorities, a recognition tentative before the war, but now, owing to the difficulty of obtaining qualified men experienced in radiological technique, a recognised procedure on the part of many institutions, constitutes a danger to the future development of radiology as a definite branch of practical medicine.

A still more marked departure from the normal state of things is the appointment of a medically qualified and experienced radiologist under the control of a man not medically qualified. This latter position is one that should receive no recognition from governing bodies and sections of medical societies whose work lies in controlling the ethical grounds upon which qualified men base their practice.

While the present demand for radiologists exists there is little likelihood of any remedial measure being employed with any degree of success, for the needs of the country are of more vital importance than those of any particular section of the community. It is the duty of all to do their utmost to meet the unprecedented demand for radiologists, and further steps might be taken to train men for the work. It may even be expedient for medical men to aid in all ways possible the training of a sufficient number of lay men to meet the demand.

The need, therefore, for a clear outlook into the future is very necessary. What is going to happen when, in the course of time, conditions return to the normal?

To the practical man it is quite clear that the importance of radiology in the fields of practical medicine will be increasingly recognised as methods and technique improve and experience accumulates. It is equally clear that the future of the medically qualified radiologist is bound up with this advance, and if the recognition of these methods in diagnosis and treatment is to receive its proper status from the medical profession, the control of all branches must be in the hands of medical men. This recognition has been freely given to other branches of practical medicine, such as Pathology, Bacteriology, etc.; teaching facilities have been arranged for these subjects in the medical schools and universities, but, up to the present, this can hardly be said for the very important subjects of Radiology and Electrotherapeutics.

The future is full of promise for medical men who are willing to devote a portion of their time to the study of physics and the mechanical details of electrical apparatus, and the inclusion of a short course on these subjects in the medical curriculum would be sufficient to induce a percentage of the medical students attending the medical schools, to devote their future to the further study of radiology and allied subjects.

In order to encourage such men certain inducements must be held out. The full recognition of the radiologist at all hospitals as a member of the staff, with all the privileges that such a position carries, would aid in the advancement of the subject. Governing bodies should see to it that none but the best qualified men obtain these posts, and on no account should an unqualified radiologist be allowed to hold such appointments. Such an anomaly would not be tolerated in any other branch of medicine.

Should such measures be taken, in the course of a few years it would be possible to train a sufficient number of men to hold all the available posts at hospitals and medical schools throughout the country, and the future of radiology, so far as the practical side of the work is concerned, would be assured.

The establishment of one or more chairs in Radiology and Electrotherapeutics at the universities would go far to provide the necessary stimulus to investigating which the matter demands, and would hold out to aspiring men sufficient inducement to take up a subject whose horizon widens with the coming years,

THE "ARCHIVES" LIST OF RADIOLOGISTS AND ELECTROTHERAPEUTISTS.

We venture to call the attention of our readers once more to the List of Radiologists and Electrotherapeutists which is in course of preparation. The response to our appeal that readers would fill in the printed form appearing at the end of the Archives has not been so complete as we could desire. We are anxious that the list should be published at an early date, and we trust that those who have omitted to do so will, in the near future, send the desired data to the publisher's office.

PRELIMINARY NOTE ON A NEW METHOD OF BULLET EXTRACTION.

A. E. Barclay, M.D. (Cantab), Capt. R.A.M.C. (T.), 2nd Western General Hospital, Manchester.

The idea of removing foreign bodies by the direct guidance of X rays is almost as old as the discovery of the X rays themselves. As a house surgeon, one resorted to the X-ray department with those cases of needles in the hand where one found difficulty, and doubtless many others did the same. But although this procedure was of assistance, it was a difficult combination—the need for adequate light for operating, and the essential accommodation of the retina for seeing the shadows in the dark, being the most insuperable. Other troubles were the difficulty of maintaining asepsis in the dark, ignorance as to what one was picking up as well as the foreign body, and, perhaps more than anything else, the dangers of injury from the X rays.

Partly from reading Dr. Caldwell's[1] papers on the co-operation of the surgeon and radiologist in combined operations in the extraction of foreign bodies under X rays, but more as the result of seeing operations, and the scars which many of our soldiers carry in witness of the extensive operations, sometimes unfortunately ineffective, that have been undertaken to remove foreign bodies, it seemed to me that something more than the usual localising of a bullet was demanded of the radiologist in a military hospital. That this demand has been recognised by others is evident from the multiplicity of instruments that have been brought out by radiologists to assist surgeons in the removal of foreign bodies that have already been localised, *e.g.*, the telephone probe of Sir J. Mackenzie Davidson, the electro-vibrator of Bergonié, our President's director, and various other devices. Not that one lost any confidence in the accuracy of one's localisation methods, but quite a small alteration in the position of the patient or the limb might make a big difference by the time the surgeon had cut down to the required depth. Or the surgeon might not go down quite straight, as is only natural when retractors must be used. Or, as in the buttock, the skin mark that one made was capable of gross displacement by slight forces. These and other factors suggested that some further guide was necessary—the operations seemed altogether too

[1] *Lancet.*

extensive for the extraction of a foreign body, provided absolutely reliable guides could be given. Accordingly, when one saw cases of bullets deeply situated in fleshy parts, one marked these cases as suitable for closer co-operation between the radiologist and surgeon. Many of these were dealt with, with considerable saving of time and cutting, by means of long Hagedorn needles (No. 1 size) pushed down through an iodine pad, till the bullet was felt and seen to move on the screen.[2] After the foreign body was felt, the projecting portion of the needle was broken off. One was at once struck with the great advantage of right-angled instruments (originally suggested for this work by Wullyamoz,[3] of Lausanne), the ordinary Hagedorn needle holder being fairly satisfactory, and enabling one to follow the course of the needle. It was sometimes surprisingly difficult, however, to keep straight and hit the target, especially at a depth of say three inches—little wonder then if a surgeon, working through retractors, wandered an inch or more from the line in such operations. But there were difficulties about this co-operation, for it was found that any movement on the part of the patient might displace the needle—on many occasions I was unable to feel the bullet with the needle after the patient had been moved to the theatre on a stretcher, even under an anæsthetic in some instances.

There was also the trouble that the foreign body, particularly shrapnel balls and pieces of lead, might be displaced by the operator without being felt. In one such case the foreign body moved nearly three inches, and was eventually quite easily felt with the assistance of a little pressure from the other side of the thigh.

With this experience, one began to wonder whether an actual cutting operation was necessary for the removal of foreign bodies embedded in the flesh—could not something be devised that would combine :—

(1) An instrument that would find its way down without cutting, apart from a primary skin incision ;
(2) That would dilate a passage through which the foreign body could be removed ;
(3) That would be sufficiently powerful to grip and extract the foreign body ;
(4) That allowed a clear view of what was happening at the points ;
(5) That combined some electrical contrivance that would take the place of the tactile sense, *i.e.*, tell one that the instrument had laid hold of nothing but the foreign body—this by far the most important feature ;
(6) That would avoid damage in pulling out rough pieces ;
(7) That would be sterilisable ;
(8) That would afford protection to the operator.

Such an instrument would have to be made in the form of a forceps of some kind.

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[2] Originally suggested by Professor Roux.

[3] ARCHIVES OF THE ROENTGEN RAY, April, 1912. In this article Dr. Wullyamoz described right-angled instruments, including scalpels, forceps, and hypodermic needles. The operations were done in part only by X rays, and the operator had the fluorescent screen attached to his head, *i.e.*, his face was directly exposed to the rays.

1. Apart from a small skin incision, a blunt dissector would find its way down through muscle and fibrous tissue with comparatively little disturbance beyond the separation of the fibres. One of the blades of the forceps must therefore be a little longer than the other, and be finished as a blunt dissector. In order that no fibres should slip in between the two blades, the shorter one must be hidden in the longer and fit right into it.

2. The blades would be sufficiently strong to be opened out and used as a dilator to widen out the channel made by the dissector point.

3. To make the forceps powerful they must be very strongly made, and the ends would be so fashioned as to make a firm grip on round or rough pieces.

4. To get a clear view, the prongs of the forceps must be at right angles to the handles, in order that the hands would be out of the way. Also the prongs must be inclined to each other so that there would be a space of about an inch and a half between them at the top. A small fluorescent screen would be fitted above this gap on the forceps themselves.

5. To replace tactile sense one of the prongs must be insulated, while the other would be in direct connection with the forceps. At the points they must be insulated from one another by a piece of fibre let into the spoon of the longer prong where the shorter one touched. Contact would be made, not when the dissector touched, but when the point had found its way down the side of the bullet, so that both prongs touched the foreign body. This would ring an electric bell. Then the blades would be opened—keeping the bell ringing all the time—until one saw on the screen that the bullet was enclosed and held by the forceps. If this could be carried out, nothing else could be picked up except the foreign body, and it could be safely extracted.

6. To avoid damage from rough and sharp fragments as they were extracted, it would be necessary to have some form of retractor. For this purpose another pair of forceps, of the mouth-gag type, would be made with a pair of blades whose ends would sheathe half round the prongs of the extracting forceps. When necessary these would be slipped down the prongs to the required depth, after the fragment had been gripped, and then expanded in the same way that an anæsthetist forces the mouth open.

7. With the exception of the fluorescent screen, the whole instrument would be made of metal and would be sterilised. The electrical connections would be covered with rubber and could also be sterilised. The fluorescent screen, which would not stand heat, would be encased in celluloid and could be kept in antiseptic solution.

8. Before the operation commenced the ordinary localisation would be carried out and a skin mark made. When this had been done the tube would be left centred exactly under the foreign body, with the diaphragm closed down to a small square. Instead of wearing gloves, a sheet of X-ray proof rubber, with a hole about three inches square, would be spread over or under the part, the hole being of course for the purpose of operating. There would be no need to have lead glass on the fluorescent screen, as the

operator would work from the side and would not have his face in the unprotected area.

So much I wrote before I had actual experience of the instrument—one was extremely hopeful, for the sake of the patients, that it would be successful. Not that one holds any belief in the removal of every foreign body, but there are thousands of cases where a surgeon does not feel justified in undertaking an operation for comparatively slight disability—a disability that may or may not wear off with time, and which frequently makes all the difference to the patient; and there are the foreign bodies in the brain which few surgeons care to interfere with unless the condition is really urgent; the ghastly comminuted fractures, with pieces of metal lodged among the fragments and many other combinations of metal and the human body, products of our twentieth century " civilisation " with which every doctor in the land is now only too familiar.

Then, in civil practice—how many house surgeons can look back without misgivings as to the ultimate fate of certain needle cases where, after long search, may be, they found that elusive needle, but at a price, measured later on by destroyed function, or possibly by the intervention of sepsis?

Naturally, in devising such a method, one expected to find that in practice there would be many difficulties, and in ordinary times one would have waited a long time before giving publicity to such an instrument as this. But it is already evident from the first cases that there is a very wide and immediate field of usefulness opened up. Imperfect as I feel sure the present instrument will be found later, there is no time to be lost in giving others the opportunity of testing, helping in the work of perfecting an instrument that will, I trust, play quite an appreciable part, not only in transforming many major into minor operations, but in rendering many a man fit once more for military service.

Naturally, the earlier such an operation is undertaken the better, for there will be fewer resulting adhesions, and I hope that before the streams of wounded come in, this instrument will be in the hands of men who have already made themselves masters of its use. For, simple as it was in theory, it is by no means so easy as one expected. Perhaps the best way of illustrating the difficulties is by a brief description of my own cases. This will also serve to explain the various modifications that practice has shown to be necessary.

CASE 1.—December 23rd, 1915. Piece of steel, ⅜ in. long, like a needle, in thenar eminence of the hand. It had been missed at the operation the previous day. The wound was not exactly over the needle, and I could not work the instrument diagonally to the shadow of the needle. By rotating the hand, the shadow was made to correspond to the wound. The prongs were again inserted, and almost at once the bell rang and there was no difficulty in picking up the fragment and drawing it out. This extraction was performed with the forceps in its rough state and with large prongs!

CASE 2.—January 13th. A minute fragment of steel, ¼ in. long, like a needle, in the hand of a munition worker. It was so small that one took it for granted it must be superficial—it was not, as I found when the local anæsthesia failed! A general anæsthetic was given, and in the meantime a localising plate was taken, which showed at once that the fragment was deep, in fact it was well behind the middle of the metacarpals. The bell began to ring almost as soon as the instrument had burrowed down through the palmar fascia to the required depth, and the fragment was extracted fairly easily. This was the first trial with the fine prongs.

CASE 3.—January 16th. Irregular pieces of iron lying behind the femur, just below the great trochanter. In the steriliser the insulating fibre button came out of the prong and one had to disconnect the bell till the bullet was felt. The bell was then put in circuit, but was of value only when the prongs were separated.

As soon as the bullet was touched it was seen to slip away about two inches, *i.e.*, it was lying in a pocket of pus. It was not possible to make the shadow correspond to the wound of entry, and another incision was therefore made and the extraction was performed without difficulty.

It seemed to be an easy matter to make the point of the prongs go down half an inch at a time and then to open them out. The instrument was powerful enough for the work, but it was a strain on the hands trying to separate the points.

To overcome this difficulty, the handles were made like those of a pair of scissors, but the alteration was not complete till January 30th.

CASE 4.—January 16th. Splatter of lead apparently touching the sciatic nerve behind the acetabulum. This case had been operated on, but the foreign body was not found. It lay four inches higher up than the centre of the surgeon's incision: whether it had moved this distance before or during the operation I cannot say.

As the long prongs had lost the fibre button, a short pair had to be used in this case, and the difficulty was chiefly due to the wider angle between the prongs—*i.e.*, nearly 30°. Although the blunt dissector penetrated the fat of the buttock, attempts to separate the prongs brought one of them out of the wound. The fat was divided with a knife, till fascia was seen, and then there was no difficulty in getting down to the fragment. As soon as contact was made, however, the nerve was stimulated and it was several minutes before the fragment was firmly gripped owing to the movements of the limb.

The imperfect contact with the foreign body caused a great deal of stimulation of the nerve—the electric bell circuit giving a current like that of the primary of a Faradic coil, and which one could easily feel through one's fingers. Probably there was also direct stimulation of the muscles by the prongs. The prongs were, therefore, painted with collodion, except at the points.

CASE 5.—January 20th. Small jagged piece of shrapnel in forearm giving a persistent sinus—at least this was the only fragment that was painful to the touch. It had been in four months, but there was no difficulty in getting to it or in extracting it under local anæsthesia. The operation took four minutes. From later experience I expect the fragment was lying in a pocket of pus, and therefore came away quite easily.

CASE 6.—January 20th. $\frac{3}{4}$ in. needle in palm of hand. It lay between the palmar fascia and the arch. The surgeon in an outlying town did not wish to touch it although it was giving pain. Local anæsthesia was quite efficient and the bell rang very quickly, but on six or seven occasions one gripped a strand of the fascia as well as the needle. When one realised what it was, one turned the forceps to another position and then succeeded in getting hold of the needle by itself. It took altogether seven minutes to extract.

CASE 7.—January 23rd. Rifle bullet lying against the outer side of the femur just above the condyle. (Four months standing aseptic case.)

After the incision had been made the electric bell was found to be out of order, and when this was repaired the limb had moved, and the first position could not be found again. It was apparently futile to attempt to work diagonally. Another incision was made, and no difficulty was encountered in again splitting a way through the tendon of the tensor fasciæ femoris, and the bullet was easily pulled through the opening. This case emphasises the importance of fixing the part as rigidly as possible before making the incision.

The forceps slipped off the nickel casing several times before they obtained a firm grip; the difficulty of obtaining a good hold was mainly from the twitching of the muscles.

Case 8.—January 23rd. Rifle bullet in thigh, lying against the femur at depth of 2 ins. (Seven months standing aseptic case.) No serious difficulty encountered in this case except that the muscles twitched whenever contact was made, and there was difficulty in laying hold of the bullet—probably a nerve was in contact with the bullet or with the prongs. The current for the electric bell could not be reduced lower than 2½ volts.

Case 9.—January 23rd. A damaged rifle bullet lying about 1 in. deep in the thigh. No difficulty of any kind was encountered, except that, after the bell had rung, the bullet tended to jump first to one side and then to the other, *i.e.*, the overlap of the longer prong was not sufficient. The electric shock made the muscle contract each time the bullet was touched.

Case 10.—January 30th. Small fragment of shrapnel in back. It was quite superficial, cased in a sheath of fibrous tissue and freely movable. It had to be pulled out with its sheath. The bell did not ring; it happened to be out of order, but it is doubtful if it would have rung with so dense a fibrous sheath. The case was much more suitable for ordinary excision, and would not have been undertaken if one had looked at it beforehand and had not relied on the statement that it was a rifle bullet.

Case 11.—January 30th. Rifle bullet in lumbar region, 1¾ in. deep, and lying on the laminæ of the vertebræ. There was no difficulty in splitting the fasciæ, and the bell rang quite quickly, but the bullet slipped first to one side of the prongs and then to the other, and it was difficult to catch it. It was evident that one point of the prongs ought to be considerably longer than the other. The extraction took rather less than fifteen minutes.

Case 12.—January 30th. Rifle bullet in thigh, 2 ins. deep. Previous operation not successful, and bullet about 2 ins. away from the centre of the scar. Patient refused general anæsthetic and the local anæsthetic was unsuccessful, even for the skin incision. In spite of his pluck the patient moved badly every time the bullet was touched, and the muscles even so powerfully contracted that it was a great labour to separate the blades, and one could not get a proper grip of the bullet. After a number of attempts the patient at last consented to have chloroform, and there was then practically no delay in the extraction. It turned out subsequently that this patient's objection to a general anæsthetic was that he was on furlough and did not want his time curtailed. Within half an hour he insisted on going home, with the bullet in his pocket!

It is useless to attempt operation unless the anæsthesia is perfect—a small movement upsets the alignment and the muscular contraction makes the operation infinitely more difficult—it becomes a trial of strength between the patient's muscles and those of the operator.

To overcome the difficulty of the electrical stimulation of the nerves and muscles a relay was introduced—the suggestion of Mr. Wild, one of the house physicians at the Manchester Royal Infirmary, where this work has been carried out. The current passing to the prongs is now only from one low voltage dry cell, which is ample to pull over the relay that forms the contact for the bell circuit. Instead of the interrupted bell current there is now the single galvanic shock to the nerves and muscles from one dry cell, which will probably not cause any movement of the foreign body. There will be no need to paint the prongs with collodion.

Case 13.—February 8th, 1916. Many shrapnel wounds in the lumbar region. Persistent sinus, and considerable pain—four months duration. The fragments apparently responsible for the symptoms were those located at depths of 3¼, 2½, and 1½ inches respectively. After consultation with Lieut.-Colonel Southam it was decided to attempt removal of the first two of the fragments, the small chain of shadows, at a depth of 1½ inches, not being sufficiently clearly seen on the screen. Under the anæsthetic the fragment, at a depth of 3¼ inches, was observed to move, and was probably embedded in adhesions in very close relationship to the kidney, but no blood came from the kidney after the operation.

A. First shadow.—At depth of 3¼ inches.

(1). Very considerable difficulty was encountered in this case from false contact of the bell: it rang quite definitely in response to contact, but it continued to ring, *i.e.*, the leakage of current across the tissues kept the relay drawn over, and the bell continued to ring but in an hesitating manner.

(2). It was not at all easy to see the shadow of the foreign body—it was a rather thin and rough fragment of shell and one had to rely chiefly on the electric bell, and as this was unreliable it made the extraction much more difficult than it should have been.

(3). Before incising, a needle was put down to see that the passage would be clear of the transverse process, but when the prongs were expanded, the dense fascia about the bone tended to force the points below the lower pole of the foreign body, and considerable difficulty was met with. When the cause of this was realised, the incision was enlarged upwards, and another passage made as close to the transverse process as possible, and the foreign body was then picked up fairly easily.

(4). The motor for the break seized up and had to be freed.

(5). The X-ray tube showed signs of exhaustion and had to be changed.

B. Second shadow.—At depth of 2½ inches.

This collection of fragments was removed through a separate incision. They were not at all easy to see, yet, although the bell was so unreliable, the three largest pieces were extracted with very little delay. The ease with which they were taken out suggested that there was suppuration around them.

The whole operation took rather more than an hour, but, considering the difficulties encountered, this is not surprising—the maintenance of false contact through the tissues after true contact, coupled with the difficulty of seeing the foreign body and detecting the cause of the failure to lay hold, accounting for the greater part of the delay.

An adjustable resistance was put into the relay circuit, and tests for false contact carried out with normal saline.

Case 14.—February 13th. Fragment of shrapnel, which had previously been missed, lying on the anterior margin of the glenoid fossa. It had been embedded for ten months and had never been septic. Major Burgess made the incision and the bell rang fairly soon, but there was no certainty in getting contact, and it was soon evident that the fragment was embedded in a dense case of fibrous tissue from which it could not be separated. The depth was only 1½ in., and, after a trial with the extractor, the sheath was gripped with a Spencer Wells forceps under X rays, and with considerable difficulty the fragment was felt and finally removed from the dense sheath in which it lay embedded by the ordinary method.

So far as one could judge, the electrical apparatus worked admirably, and there was neither shock nor false contact.

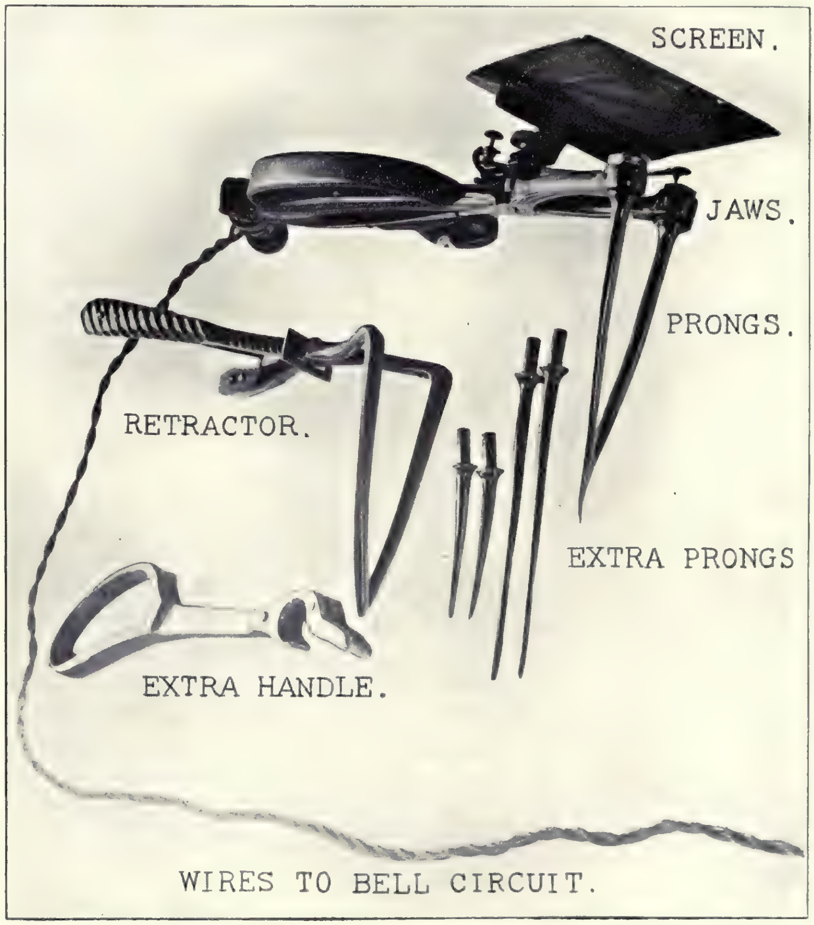
The case was evidently not one suited for extraction, as the rough coral-like surface of the fragment was too firmly adherent for any possibility of separation from its casing, except by the ordinary methods. The value to the surgeon of working under X-ray guidance was very evident in this case, for even when the capsule was fixed by the forceps, it was almost impossible to fee the fragment in it.

All the "war" cases were old injuries, and it is reasonable to suppose that extractions would be easier when undertaken shortly after the injury, before fibrous tissue had formed.

There has been no bleeding worth speaking of in any of the cases, and all the aseptic ones have healed by first intention.

Naturally, there have been numerous alterations in the instrument, but these have all been of a minor nature, *e.g.*, the gripping surfaces of the prongs, the overlap of the points, the fixing of the fibre insulation, etc. The next instrument will be made considerably stronger in the joint, the jaws of the forceps will be stronger, and the prongs will be a little thicker at the upper ends. There is no object in keeping the instrument as light as possible, and there are definite advantages in greater strength, *i.e.*, firmer grip and less likelihood of straining and of the points of the prongs being forced into false contact in burrowing, especially in removing fragments from among new formed callus and fibrous tissue. An extra handle, to attach to the far end of the jaw that is operated by the thumb, has also been made, and this will greatly assist the opening of the jaws in parts where some force is required, as in the lumbar fascia.

The Use of the Instrument.—The method of using the instrument is simple. After fixing the patient, localising and skin marking accurately, and disposing extra protection for the operator, the skin is sterilised and the area surrounded by sterilised towels, etc. A tourniquet above and below is an advantage in steadying the muscles. An incision about an inch or an inch and a half long is made down to the fascia and exactly over the shadow, the prongs are inserted and the lights are turned off. With the occasional guidance of the rays, and frequent dilatation of the prongs, a way is made down to the right side of the bullet until the bell rings. Then the foreign body is freed all down this side—the bell ringing nearly all the time. The prongs are then withdrawn about half an inch and the other side of the foreign body is also freed as far as possible—the bell, of course, not ringing. Then returning to



the right side of the bullet and making the bell ring again, the proper part of the foreign body to lay hold of is selected. The prongs are then opened, keeping the bell ringing as much as possible, until it is seen that they are sufficiently expanded to embrace when they are pressed down. Until the relay was put into the circuit it was often difficult to pick up the bullet because of the jumping of the fragment caused by muscular contraction in response to the shock. The absence of appreciable shock and the increase of the overlap of the longer prong should make the picking up of the foreign body a much easier matter. In fact, it is likely that when they have been freed, bullets will naturally slip into the grip when the longer prong is used as a retractor while the forceps are being opened, *i.e.*, the elasticity of the tissues will be of assistance.

So far, no fragments have been removed that have necessitated the use of the dilator, and, when once the bullet or fragment has been firmly gripped, it has been extracted without any difficulty—except in Case 12, when the absence of anæsthesia made the extraction through the fascia lata impossible.

It all sounds simple, and it is comparatively simple when the instrument is perfected, to anyone who is accustomed to X-ray work—but the radiologist is not, as a rule, a good surgeon, and *vice versa*, there are few surgeons who are good radiologists. The radiologist, if he does this work, must act under the guidance of the surgeon or he will make mistakes: he is likely to be shaky both in surgical anatomy and asepsis: if he is a true radiologist he will not be able to keep his fingers off the adjustments and switches. And if the surgeon uses the extractor he will probably need much more illumination, and is likely to wreck all the X-ray tubes in the department, and may possibly even burn the patient. It looks as if for the simpler cases a house surgeon, to make the incision and close the wound, is necessary, the radiologist extracting the bullet, while in difficult cases involving perhaps the exposure of, say, the subclavian artery or removal of a piece of rib or a portion of the skull, this would be done by the surgeon, the radiologist adjusting his beam of rays, obliquely if necessary, so that he can carry out the extraction from such position as is indicated by the surgeon as being free from danger.

Limitations.—What are the limitations of the method? On the radiologist's side, the fragment must be easily visible on the screen—the depth at which it lies makes little difference, but he must have free access to it—if necessary portions of ribs will have to be excised, the skull will be trephined, or, using the prongs as dilators, the long bones may possibly be trephined and bullets taken out of the medullary cavity or from masses of callus.

Cases 10 and 14 were both fragments of iron, eaten into and with a surface like coral. They were so firmly encased and entangled that no extractor could possibly free them from their sheath. On the other hand, Nos. 3, 5, and 13 were similar fragments, pitted and eaten into in the same way, and yet they came away quite easily, *i.e.*, in the septic cases the sheath does not enmesh the foreign body. Presumably, therefore, old standing aseptic cases are not suitable for extraction, although old standing septic cases can be dealt with by this method. But apparently this applies only to fragments of iron, as the nickel cased bullets and lead fragments, Nos. 4, 7, 8, 9, 11, and 12 were freed and extracted without much difficulty, *i.e.*, nickel and lead are not eroded, and therefore do not form the same intimate cohesion as iron fragments. As yet there is no experience of recently embedded fragments of iron, except the bits of steel in the hand, but one would expect that, if extracted within a few weeks, there would not be sufficient fibrous tissue to interfere with the extraction.

Working in close concert with the surgeon there should be few limitations from the X-ray point of view in recent cases, but as to the limitations and disadvantages from the surgical side, I am not competent to speak.

The obvious advantage is that only a comparatively slight track is made, and very little damage is done. In fact, the operation becomes practically a closed one. The importance of this will be obvious to anyone who is in touch with the work in the Convalescent Camps and Red Cross Hospitals, where the adhesions between muscles are treated. And in septic cases there is no infection spread except along the track that will form the sinus.

TUBERCULOSIS OF THE BONES AND JOINTS.

By R. W. A. Salmond, M.D.. Ch.M., Assistant Radiographer, King's College Hospital, Capt. R.A.M.C. (T.).

Tubercular disease of these parts is more common in young than in old people, but there is no age at which it may not apparently originate. In infancy and youth, it is the most common disease affecting these parts. Some of the bones and joints are more frequently attacked than others ; how much more often one sees the spine, hip or knee affected than the shoulder or skull. Since a knowledge of the pathology of the disease as it affects the ends of the bones and joints enables one to recognise more clearly and interpret more accurately the radiographic appearances, a short revision of its naked eye pathology in this region will first be given.

Pathology of the disease at the ends of the bones and joints.—In the bones, the site of origin is usually near the epiphysial cartilage or much less frequently in the periosteum or medullary canal. In the joints, in addition to a bony focus invading the joint secondarily, it may begin in the synovial membrane. It never starts in the articular cartilage nor the ligaments. Primary bone disease is the more common in children, while in adults bony and synovial origins occur about equally, the various joints often showing a tendency to the one or the other. As the radiographic picture is somewhat different in these two sites of origin, each will be described separately.

(*a*) *Primary bony origin.*—The tubercle starts in the marrow (never in the actual bony structure) near the epiphysial line and spreads. Fresh tubercles form and coalesce, giving rise to a larger, usually single, focus. Granulation tissue is thrown out around it, and either becomes invaded by the disease or converted into fibrous tissue surrounding and arresting it. If not arrested, absorption of the bony structure, known as caries, occurs in the focus, which sooner or later becomes caseous. If the bony structure has not been absorbed when caseation occurs, it breaks down *en masse*, forming a sequestrum. A reactive production of thickened bone may form further out around the focus. The granulations spreading in the marrow reach the compact layer of the shaft, and may break through and form an abscess in the surrounding tissues, and so reach the surface without involving the joint. Usually, however, the compact layer and periosteum do not give way, and the disease spreads in the interior of the shaft, especially towards the joint. While it is spreading towards the joint, this may be the seat of a serous effusion.

The disease may next perforate the joint, and infect the synovial membrane and other bones of the joint, or become localized to a portion of the joint. Very often it seems that when the interior of the joint becomes involved the progress of the disease is much more rapid than before. The further course depends on the formation of fibrous and soft granulation tissue. If fibrous tissue predominates, the joint contains a mass of adhesions, while if the granulations are not organised an abscess forms which eventually breaks through the capsule and reaches the surface. If the articular cartilages are destroyed, bony ankylosis may oocur, but this is rare in adults. A less common form is osseous degeneration of the ligaments, forming a "muff" between the ends of the bones.

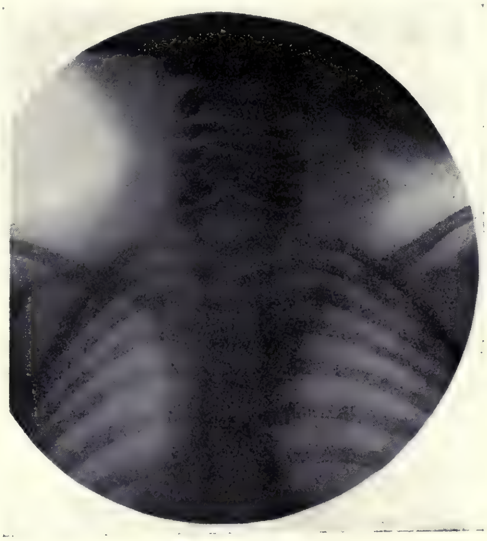


Fig. 1.

(*b*) *Primary synovial origin.*—Here the tubercle commences probably in one of the folds of the synovial membrane, and either remains localized or infects the whole joint. The membrane becomes thickened and the soft tissues around respond similarly. If not arrested, the disease erodes portions of the articular cartilages and reaches the marrow of the shaft, where its progress is much the same as in primary bony origin.

Arrest may take place at almost any stage followed by a fairly good recovery in children, but in adults the prognosis is not so good.

Diagnosis and General X-ray Appearances.—In arriving at a diagnosis it cannot be too strongly urged that the clinical examination, history, and tests should all be considered in conjunction with any X-ray examination. A negative radiographic opinion should never outweigh a careful positive clinical one. Help may sometimes be got by screening the chest, for in many cases the source of the bone or joint affection is diseased bronchial glands. The combination of joint and chest disease seems most common when the shoulder, wrist, or tarsus is affected. Negatives should always be taken, as much more detail can be seen in them in bony conditions than on the fluorescent screen, and stereoscopic views are, at times, most valuable for showing the relative position of cavities, sequestra, etc.

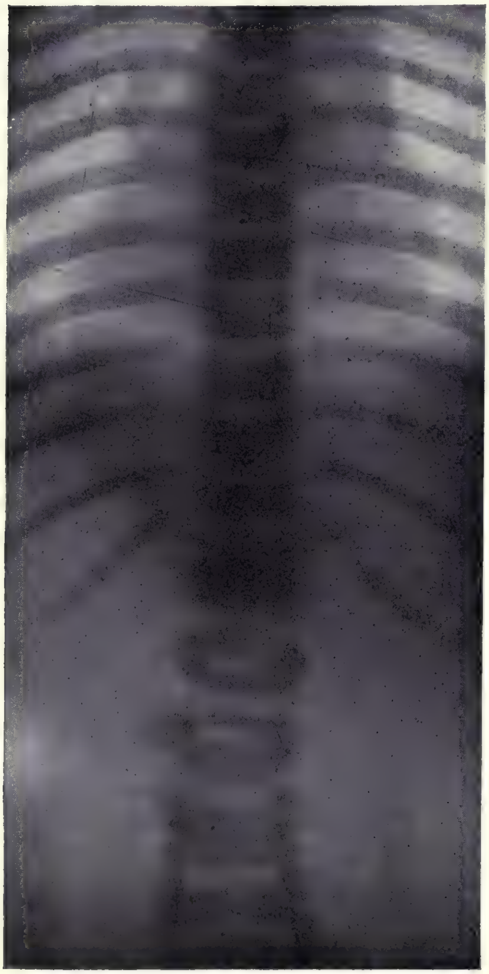


FIG. 2.

To avoid repetition, the general X-ray appearances will first be described, and then the special appearances at the various joints. It will be seen how important it is in early cases, from the radiographic point of view, whether the origin is bony or synovial, for if no bony focus is visible, the appearance, though it may be suggestive of, shows nothing peculiar to this disease only. When a bony focus is present one has more evidence to go upon, and can at least say whether the appearances are those usually seen in a tubercular condition or not. It should, however, be realised that there are few appearances seen in this disease which may not, on occasions, be caused by other conditions.

The presence on the negative of increased translucency or rarefaction of the bony structure is nearly constant in active disease of some duration, and is due to absorption of the lime salts. (Fig. 13.) All the bones of a tubercular subject may, however, show this without any bone disease being present. Increased translucency is by no means confined to this disease, but occurs whenever a bone has been functionally inactive, as after fracture, and in certain other constitutional conditions, such as chronic alcoholism. It depends also, to some extent, on the degree of hardness or softness of the tube used. By using a suitable soft tube very rarefied bone may be demonstrated with greater detail and density than with a harder tube, whose rays would pass through the thin bone and show little differentiation from the soft parts. The soft rays will also show the condition of the interior of the joint and soft parts better. It is not usually possible to distinguish between swollen synovial membrane, serous, and purulent effusions with any certainty from a skiagram alone.

The bones and soft tissues in the neighbourhood of a tubercular joint show atrophy after some time, and to appreciate this, as well as the rarefaction, the corresponding part on the opposite side, if healthy, should be X-rayed under exactly similar conditions, and, if possible, simultaneously, dressings being removed whenever permissible. (Figs. 5, 6 and 7.)

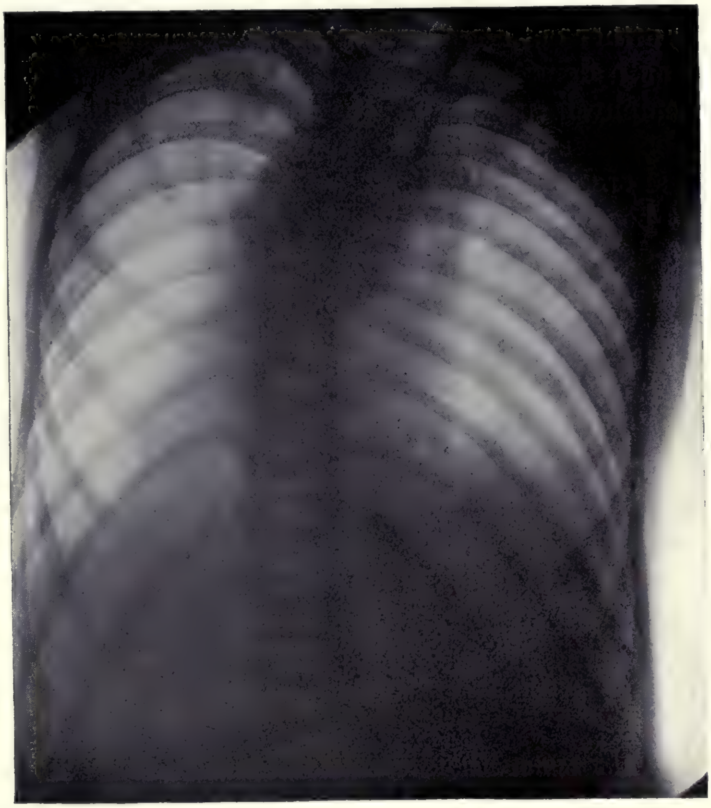


FIG. 3.

The appearances in a case affecting the bone or joint are just what would be expected from the pathology.

(*a*) *Starting near the end of a long bone.*—Until the nutrition of the trabeculæ is interfered with, a focus causes no abnormal appearances. As soon as the granulations around the focus have interfered with its nutrition, the rays pass through it more easily and cause a darker appearance on the negative ; in other words, there is an area of rarefaction. The actual disease has probably spread in the marrow beyond this rarefied area, though it is not recognisable radiographically. The irregular distribution of the granulations and their effects gives a worm-eaten and indistinct appearance to the bony structure, while the atrophy of the trabeculæ is a further cause of rarefaction. The rarefied area may increase in size and translucency, its structure becoming hazy and indefinite as caseation occurs, and later on, clearer and devoid of structure if an abscess develops. A sequestrum, if present, appears as a lighter area on the negative lying loose in this cavity. (Fig. 10.) The activity of the disease has been stated to be indicated by the appearance of the walls of a focus. Latent and healed foci are said to show a more defined margin than when the disease is active; while this is true in many cases, it is not constant. Further out a reactive sclerotic osteitis may occur, and shows on the negative as a denser white area around the focus. (Fig. 10.) The outline of the epiphysis underlying the articular cartilage, which does not normally show, becomes irregular, due probably to absorption of the lime salts rather than actual erosion.

As the joint becomes infected, its cavity appears on the negative denser than the normal dark appearance, and looks distended. This appearance is usually due to thickened synovial membrane, and, to a lesser extent, effusion. Periarticular inflammation or abscess may cause haziness and increased density in the region of the joint, and should not be mistaken for intra-articular changes. Melon seed bodies, sometimes present, do not show radiographically.

The further appearances vary greatly on the amount of destruction of the ends of the bones and cartilages, and later, on the form of ankylosis which takes place. In some, dense sclerosed bone forms, while in others the rarefaction remains for years. A medullary canal can sometimes be traced through the shafts when bony ankylosed. While the appearances of the later stages are less important diagnostically, they are of great use in showing the exact condition of the joint as the result of past, and as a guide for future treatment.

(*b*) *Starting in the synovial membrane.*—For a short time no changes are visible, but soon rarefaction of the bones occurs, and the joint cavity becomes denser on the negative (Fig. 18) and distended in outline, while the articular bony margins show irregular outlines. Such a picture may also be seen in non-tubercular infective conditions of the joint, and it may only be when the disease has invaded the bone that the appearance becomes more characteristic of this disease. After the bones are affected the appearances are much the same as those seen in primary bone infection invading the joint.

(*c*) *Starting in the short long bones.*—See under metacarpals and phalanges.

(*d*) *Starting in the shaft of a long bone.*—This is much rarer than the preceding forms. The negative shows the focus as a translucent area, which in time increases in size and translucency, and generally expands the shaft. It may or may not be accompanied by periostitis seen as a delicate shadow running along the shaft at a corresponding position.

(*e*) *Starting in the periosteum.*—Periostitis is set up and only shows radiographically after it has existed for some weeks and lime salts have become deposited in it. It then appears as a faint shadow made up of fine lines running parallel to the bone, but usually separated from it by a clear area. It is not possible from a skiagram alone to determine its nature, and it may be only when the disease has eroded the underlying bone that some help as to its nature is got radiographically.

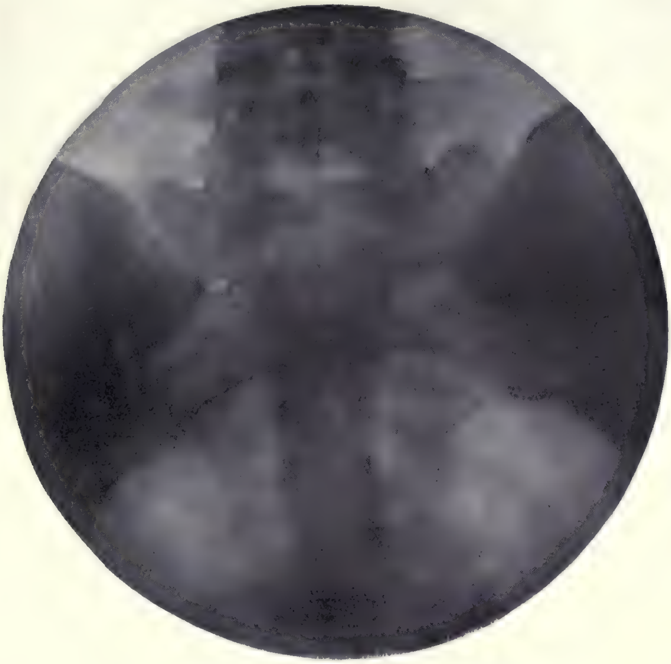


FIG. 4.

General Differential Diagnosis.—The most likely conditions to be mistaken for it radiographically are:—Osteitis, epiphysitis, syphilis of bone, bone cyst, sarcoma, infective arthritis, synovitis, hæmarthros. Those specially applicable to the various joints and bones will be mentioned under these parts.

SPECIAL POINTS IN THE MOST COMMONLY AFFECTED JOINTS AND BONES.

(For general appearances see before.)

Spine.—Disease of the vertebræ is the most common tubercular bone affection in children. Any of the vertebræ may be affected from the atlas to the coccyx, but the most usual seat is the middle or lower dorsal. The site of origin may be in the interior of the body, the periosteum or the synovial membrane of one of the articulations. Rarely it commences in the transverse or spinous processes or laminæ.

Usually it starts in the substance of one of the bodies near the intervertebral fibro-cartilage, and shows on the negative as a small area of rarefaction.

This increases in size, and the nutrition of the intervertebral disc is affected and eventually destroyed, so that the cancellous tissue of adjacent vertebræ becomes apposed, and the disease thus spreads from body to body. This causes the clear space normally seen between the bodies of the vertebræ to disappear, and is one of the things first looked for when examining a spine for this disease. As it progresses the nutrition of the trabeculæ becomes destroyed and the body of the vertebra collapses. The entire vertebra does not, however, collapse owing to the articular processes of denser bone usually remaining intact, and acting as a hinge, causing angular deformity forwards. In well marked cases one sees telescoping of a few of the bodies of the vertebræ together with loss and irregularity of their outlines. If in the dorsal region, the relative position and direction of the ribs also show deformity. When investigating the lumbar and sacral regions, the stomach and intestines should be as empty as possible, as in renal radiography. Often the presence of a spinal abscess can be detected as a well defined rounded or pear-shaped light area on the negative, usually on both sides of the spine at the seat of disease. This must not be confused with the cardiac shadow and is not common in very young children. The amount of deformity is often best seen in a lateral or semi-lateral view taken in addition to the more usual antero-posterior one.

The disease sometimes starts, especially in adults, in the periosteum and shows as a periostitis, with later on an eroded appearance of the surface of the bone as it becomes affected.

If a sinus is present great help may be got by injecting into it a warm sterilised emulsion of bismuth (Bismuth oxychloride 1 part, liquid paraffin 1 part, and vaseline 2 parts) and then taking a radiograph. The track of the sinus, if properly injected, can often be traced to a diseased focus in one of the vertebræ. Besides the diagnostic value of this procedure, some good therapeutic results have been recorded.

Differential Diagnosis :—

Injury, especially in cervical region.
Typhoid spine.
Sarcoma.
Secondary malignant disease.
Hysterical spine.

Fig. 1 shows erosion and absorption of the bodies of the first three dorsal vertebræ in a young child.

Fig. 2 shows disease of the eleventh and twelfth dorsal and first lumbar vertebræ, the greater part of the last dorsal one having nearly disappeared.

Fig. 3 shows disease of the mid dorsal region with abscess formation.

Sacro-iliac Joint.—This may be involved secondary to disease of the lumbo-sacral spine or affected primarily. When the latter, it starts in either of the two bones and invades the articulation, the skiagram showing erosion of the outlines and obliteration of the line of junction of the two bones. Later on, evidence of caseation, necrosis and sequestra may be seen.

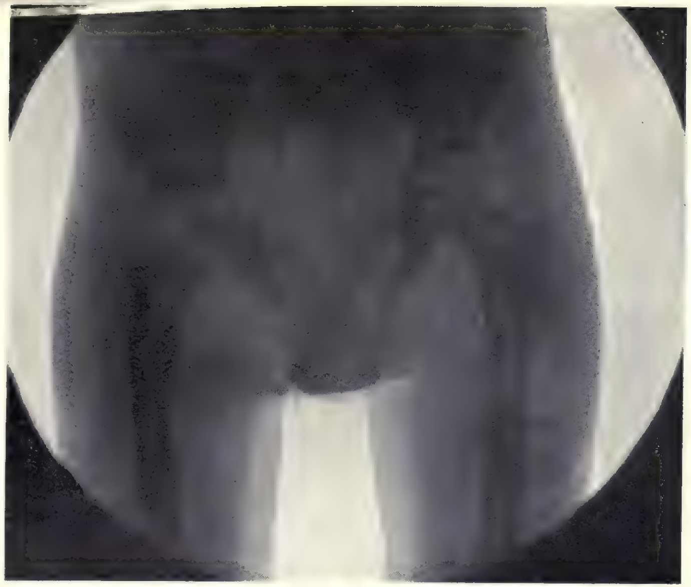


Fig. 5.

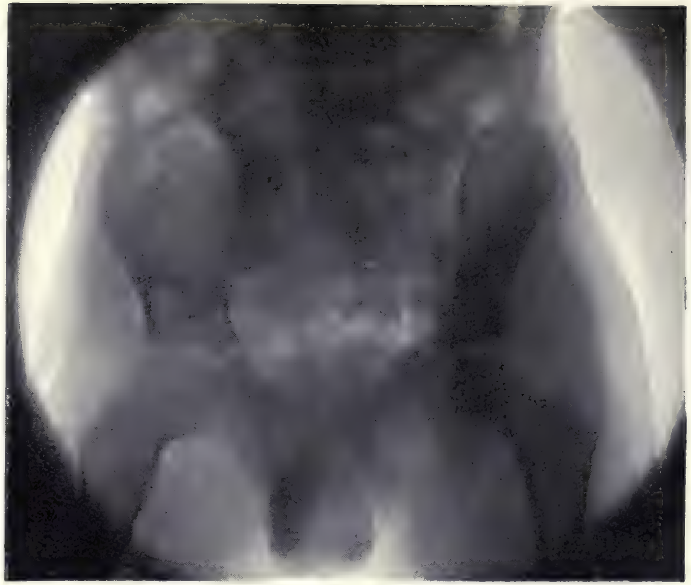


Fig. 6.

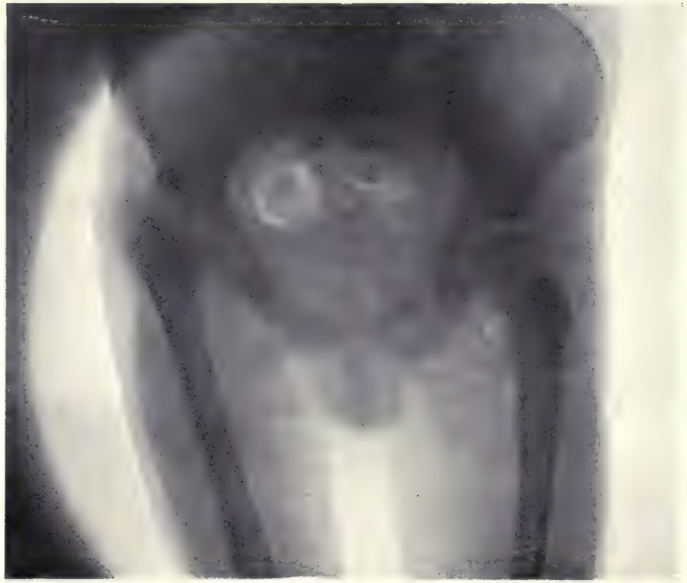


Fig. 7.

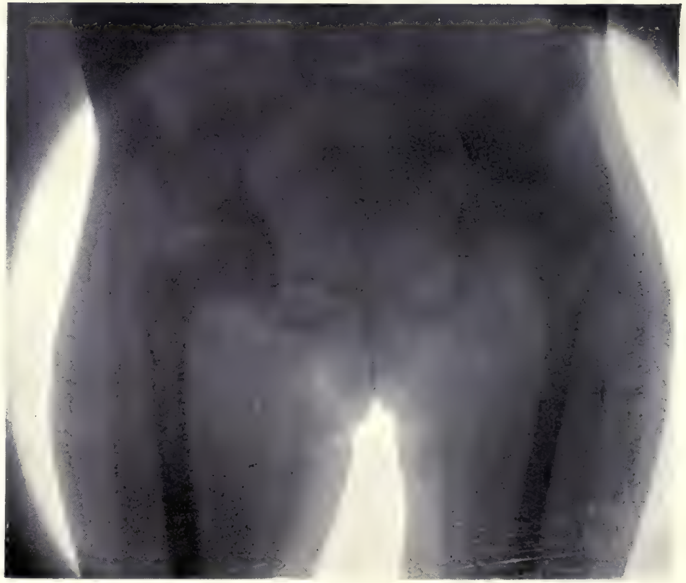


Fig. 8.

Plate 37.

TUBERCULOSIS OF THE BONES AND JOINTS.

By R. W. A. Salmond, M.D., Ch.M.

Differential Diagnosis :—

Calcified patches in the iliac vessels simulating sequestra.

Fig. 4 shows the appearance in an early case of this disease. Erosion and indistinctness of outline is seen at the upper part of the articulation on right side, but no rarefaction is as yet present.

Hip Joint.—This is one of the most frequently affected joints in early life. The site of origin may be in the neck or head of the femur, the acetabulum, or more rarely, the synovial membrane, or at the great trochanter. A good method is to place the plate under the patient lying on his back, with the tube centred in the median line over a point midway between the centres of both joints, and at some distance off to diminish distortion. Care should be taken that both lower limbs are kept as nearly as possible in the same relative position by sand bags or other means. In this way the abdominal respiratory movements can be ignored, and both joints are taken simultaneously for comparison. Among the earliest changes are rarefaction and atrophy of the femur and pelvis on the affected side and haziness in the joint cavity. A characteristic appearance is that of a bony shadow projecting inwards from the pelvic side of the acetabulum, as if the head of the femur were pushing the portions of the acetabulum into the pelvic cavity, while tilting of the pelvis is usually present. Bony erosion may be seen as a clearer irregular area on the negative, and the epiphysial line of the femur or acetabulum may be irregular and ill-defined. As the disease advances, the articulating surfaces become eroded and softened, and are absorbed by pressure due to muscular spasm. The result is that the head of the femur assumes a flattened shape, and the acetabulum is absorbed at its upper and back part and so enlarges. The articulating surfaces thus come to be at a higher level (wandering acetabulum) (Fig. 7), but actual dislocation is rare. Shenton's line (the top of obturator foramen and inner side of femoral neck forming an unbroken arch) is of great use in determining the amount of displacement. The joint cavity generally casts a denser shadow on the negative than normal, due to bony débris and inflammatory products, and, perhaps, infiltration of these into the surrounding tissues. The disease may progress until the head and neck of the femur are entirely absorbed.

Old standing cases may show a markedly deformed joint, with either bony or fibrous ankylosis, still remaining atrophy of the affected bones, and the femur displaced upwards on the pelvis. In others, the appearance is more normal, though extensive disease had occurred years before.

Differential Diagnosis :—

Osteitis.
Epiphysitis.
Gummatous epiphysitis in infants.
Separated epiphysis.
Coxa vara.
Congenital dislocation.
Synovitis.

Rheumatoid arthritis.
Syphilis of bone (rare).

Fig. 5 shows early disease at the left hip. Slight rarefaction of the bones at the joint is present, while the margin of the acetabulum is irregular, especially its upper part, which is eroded. The femoral epiphysis and epiphysial line are not so definite as on the opposite side. There is not, as yet, any atrophy.

Fig. 6 shows the disease on the left side starting in the iliac portion of the acetabulum, which is much eroded, though the corresponding part of the head of the femur shows no erosion. Rarefaction of the femur and pelvis on the affected side is evident.

Fig. 7 is a case of well advanced disease on the left side. The head of femur has been absorbed while the neck and great trochanter are undergoing absorption. The acetabulum has also been absorbed to some extent, and the high level of the joint is well seen. The joint is seen distended with the débris of the destroyed bone, and atrophy of the affected half of the pelvis is present.

Fig. 8 shows double hip disease of longer standing on the right side. General rarefaction of the bones is seen, and on the right side erosion of the head and neck of the femur and acetabulum with atrophy of the femoral shaft. On the left side the head and neck of femur and acetabulum are eroded, and, owing to softening of the bones, the neck is in a condition of coxa vara. Under the neck an abscess is seen containing a sequestrum in its centre, while tracking down inside the tensor fasciæ femoris some of the débris and pus is seen.

(To be continued.)

THE LIGHT FROM THE SIMPSON ARC LAMP.
(THE SO-CALLED "SIMPSON LIGHT.")
ITS NATURE AND THERAPEUTIC PROPERTIES.

By Alastair MacGregor, M.D. Edin. and C.M.
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The light from the Simpson Arc Lamp, one of the latest additions to our list of remedial agents, has been brought into specially prominent notice by reason of articles in the lay press. Some of those have been written with more zeal than discretion and scientific knowledge. In one instance, for example, the light from the Simpson Arc Lamp is described as "a new X-ray," but with this radiation, in point of fact, it has nothing in common. Indeed, early in our investigations at St. Bartholomew's Hospital, we found that the rays had no power of penetrating opaque objects. It is regrettable that such misleading statements have appeared in the lay press, as they are liable to prejudice the medical profession against this remedy before time and opportunity have been given to investigate the full extent of its potentialities.

References in the Medical Press :—

(1) "Cases illustrating results obtained by use of Simpson Light," by W. Douglas Harmer, M.C. Cantab., F.R.C.S. Eng. (Proceedings of the Royal Society of Medicine. December, 1915.)

(2) "The Simpson Light : its nature, mode of production and application," by W. Douglas Harmer, M.C. Cantab., F.R.C.S. Eng. and E. P. Cumberbatch, B.M. Oxon., M.R.C.P. Lond. (*The Lancet*, January 8th, 1916.)

(3) "The Simpson Light in the Treatment of Venereal Lesions," by E. G. Ffrench, M.D. Edin., F.R.C.S. Edin., Major R.A.M.C. (*The Lancet*, January 29th, 1916.)

(4) "From the Visible to the Gamma Ray Spectrum," by Sidney Russ, D.Sc. (*British Medical Journal*, January 22nd, 1916.)

(5) "Some Experiments with the Simpson Arc Lamp," by J. H. Sequeira, M.D. Lond., F.R.C.P. Lond., F.R.C.S. Eng. (*The Lancet*, February 19th, 1916.)

(6) "The Treatment of Septic Wounds with the Simpson Light," by J. A. Menzies, M.B., C.M. Edin. (*The Lancet*, March 4th, 1916.)

In addition to the above-mentioned, a paper by the author, entitled "Remarks on the Simpson Light," appeared in the *West London Medical Journal* for January, 1916. There was also, in January, 1916, a discussion on the subject in the electrotherapeutical section of the Royal Society of Medicine. The discussion was opened by Dr. E. P. Cumberbatch and Dr. Sidney Russ. [See proceedings of Royal Society of Medicine.]

In March, 1913, Mr. Simpson, a Scottish engineer, resident in London, when investigating the affinity of rare metals for each other, noted that the light produced by the electric combustion of certain ores "had curative effects in cases of eczema, acne, asthma, and other affections" among his workmen exposed during their work to the light and the fumes derived from the combustion of the metallic ores.

Attempts were then made to prepare from those ores electrodes suitable for combustion in an arc lamp. This proved to be a difficult matter. It was found that very elaborate processes were necessary for the proper purification and refining of the ores used for the purpose. Any appreciable amount of impurities makes even semi-combustion impossible, because the impurities fuse on the incandescent points of the electrodes and sometimes establish a connection between them, with the result that the arc light goes out. Over eighteen months were devoted by Mr. W. G. Moore, M.I.M.E., to experiments before a satisfactory result was attained, and even now the most suitable composition of the special electrodes has not been fully determined.

The Simpson Lamp owes its special properties to those electrodes which are not composed of gas carbon, as in the more familiar type of arc lamp, but of a mixture of certain metallic ores, the chief constituent being Wolfram, which is a tungstate of iron and manganese.

The physical properties of the light have been investigated by Professor Burstall and Professor Horton, and more recently by Dr. Sidney Russ.

Professor Horton's investigations may thus be summarised :—

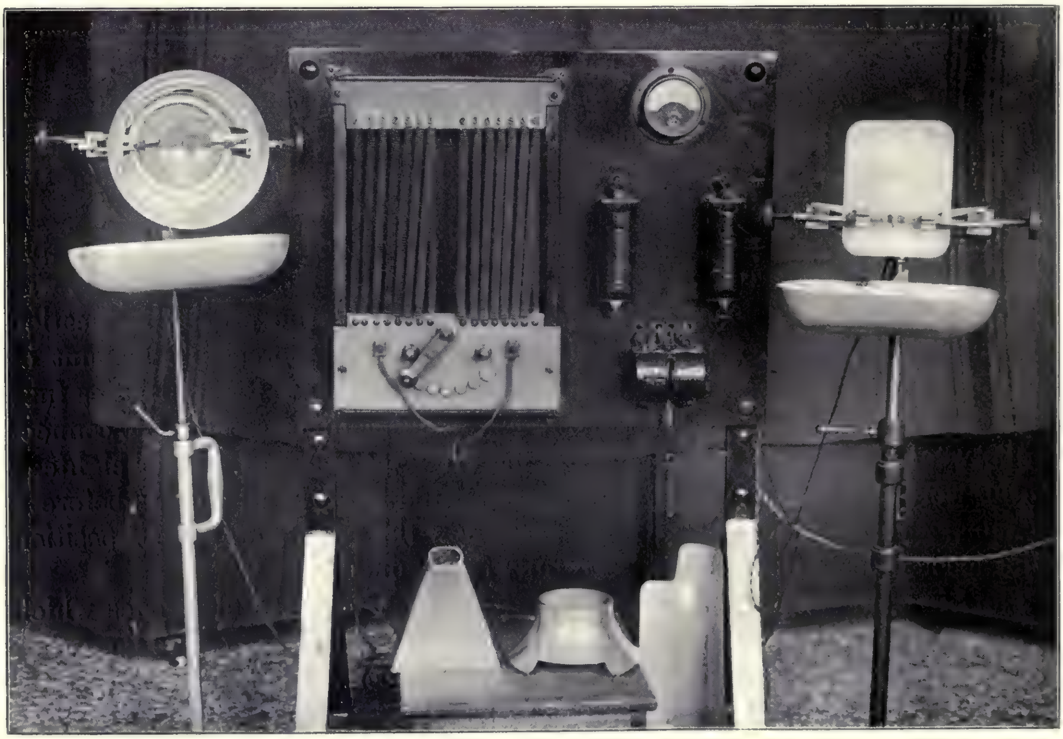
(1) Spectroscopically, a spectrum of the light obtained by means of a quartz

prism was cast upon a fixed screen, the upper part of which was composed of white paper, the lower part of fluorescent material.

Under exactly the same conditions as regards position and adjustment of the electrodes and the amount of current used : (*a*) the length of the ultra-violet portion of the spectrum in the case of the carbon arc-light was measured as 10 cms. ; (*b*) the length of the ultra-violet portion of the spectrum in the case of the Simpson arc-light was measured as 19·5 cms., and this was much brighter in the more refrangible parts than had been the case with the carbon arc.

(2) Photo-electrically (meaning by this the power which ultra-violet light possesses of discharging negative electricity from certain metallic conductors). In this investigation a plate of metallic copper, coated with copper oxide, was employed, and a new form of electroscope was devised for testing the rate of leak. After many tests were made, using the carbon and the metallic arcs, being employed alternately, as a source of radiation, Professor Horton found that the arc between the metal electrodes was a much more powerful source of ultra-violet light than was the carbon arc—probably between five and ten times as strong.

(3) In making comparisons between the new (Simpson) arc and the arc obtained under similar conditions with electrodes of other metals known to be good as sources of ultra-violet light, viz., aluminium, zinc, and cadmium, Professor Horton found that in every case the radiation from the Simpson arc was considerably the more powerful.



From those investigations it is evident that the light from the Simpson Arc Lamp is not only very rich indeed in ultra-violet rays, but that it also contains rays of shorter wave-length than does the light from a carbon arc; and it is doubtless the greater richness of those ultra-violet rays, and the presence of those rays of shorter wave-length, in addition to the visible and heat rays, which give the arc-light from the Simpson Lamp its therapeutic properties.

It is apparent, then, that the so-called "Simpson Light" is really ultra-violet light with the addition of visible light. There is no evidence of the existence of any new form of radiation, and it is therefore inadvisable to make use of such expressions as "Simpson Light" or "S. Rays." The radiation should be spoken of as "the light from the Simpson Arc Lamp."

The Simpson Arc Lamp apparatus consists of the lamp and stand and a switchboard with switch, ampèremeter, and appropriate fuses and resistances for the purpose of lowering the voltage and ampèrage of the main current to a suitable value.

The lamp is mounted on a portable stand, which can be raised or lowered or otherwise adjusted so that the light can be directed where desired. The special electrodes are fixed in clip-holders, and their points can be approximated or separated by means of an easily-working hand screw. A metal tray in front of the lamp catches any flying bits of molten metal thrown off from the arc when the lamp is burning. A current of 5 to 7 ampères is required at a voltage of 50—60.

In applying the light either the "open arc," or the "focussed arc," or the "medium focussed arc" may be used. The first is most suitable when treating larger areas, the two latter are used for smaller areas where more intense treatment is indicated. In the open arc method a plane sheet of metal is slipped over a metallic upright which is behind the electrodes, and the latter are placed 10 to 15 inches, usually 12 inches from the area to be treated. The patient is blindfolded, a pad of cotton wool being placed over each eye and bandaged on. All parts which it is desirable not to expose to the light are covered with a layer of lint. The operator wears blue lead glasses, otherwise he may develop conjunctivitis. The light impinges directly upon the area to be treated. The first exposure in new cases should be one minute. This exposure may be increased in subsequent treatments to two, three, four, or five minutes, or even more. The duration of the exposure should depend upon the reaction of the skin after each exposure. The reaction varies considerably. In the "medium focussed arc" method a parabolic reflector, either of polished metal or of "Wood's Fusible Alloy," is substituted for the plane sheet of metal. By this the rays are reflected to a blunt focus, and areas of medium size can thus be treated. In the "focussed arc" method a parabolic reflector is placed behind the arc so as to bring the reflected rays to a sharper focus, and the smaller area to be treated is placed at the focus of the reflected rays. In both focussed arc methods the duration of exposure is the same as that in the open arc method, *i.e.*, always beginning with one minute and gradually increasing afterwards as indicated by the amount of reaction observed. The application of the focussed rays throws considerable heat on the area treated ; if the heat be excessive the distance between the arc and the patient is increased.

The arc light of the Simpson Lamp is very dazzling, and is accompanied by a spluttering, hissing noise. From the combustion of the metallic electrodes a white vapour is given off, and this, when inhaled through a special funnel, which can be affixed to the metallic upright behind the electrodes of the open arc lamp instead of the plane or medium focus reflector, seems to be of value in the treatment of certain affections of the respiratory passages. In this method the initial treatment consists of inhalation for one minute, then an interval of half a minute ; then inhalation for another minute. The duration of treatment afterwards may be increased or decreased according to the effect produced on the patient.

In this, as in the other methods of treatment, after every application instructions are given to the patient to make a careful note of the effect produced. We never repeat a treatment until the reaction of the previous treatment has passed off, otherwise more or less inflammation may ensue, and improvement may be retarded. The reaction varies from slight tingling in or near the area treated, which may last from one to five hours, to considerable irritation and erythema, which may last from five to forty-eight hours, leaving subsequently no traces except occasional slight desquamation. The reaction, if any, is usually not apparent until some five or six hours after the exposure. By varying the length of exposure and the method of application (*e.g.*, from the focussed arc to the open arc method) according to the condition of the local lesion, any undesirable amount of reaction can usually be prevented. But some patients seem to have an idiosyncracy to the rays, hence the importance of giving a moderate exposure in every initial treatment, and of, as a rule, beginning the treatment of a new case by employing the open arc method. If, however, excessive reaction be produced in patients exceptionally susceptible to the rays, the application of almond or olive oil or boracic powder or ointment will relieve the irritation. Patients should be cautioned not to apply severe friction to the skin (such as rubbing with coarse towels) for at least twenty-four hours after treatment.

As a general rule, at St. Bartholomew's Hospital, we give two or three treatments a week to each patient.

Experiences with the Light from the Simpson Arc Lamp.—Since a Simpson Lamp apparatus was installed in the electrical department at St. Bartholomew's Hospital, in July, 1915, a number of cases with various types of disease have been treated. All of them had received previous treatment, and a great proportion of them were of a chronic type. It is, at this early stage, difficult to specify the diseases or symptoms for which the Simpson Arc Light seems pre-eminently the method of treatment. Before venturing upon any dogmatic statements as to therapeutic properties peculiar to the light from the Simpson Arc Lamp, it is necessary to make sure that similar properties are not possessed by other sources of ultra-violet light.

It is equally necessary to be sure that cases which have derived benefit from the Simpson Arc Light would not have derived equal benefit from other forms of treatment. Most of the cases, however, that have been treated by the light from the Simpson Arc Lamp at St. Bartholomew's Hospital have resisted other forms of treatment.

Of the forms of disease which have responded well the following may be specially mentioned :—

A. *Rodent Ulcer.*—Two of those were very extensive and profuse suppuration was going on. As a result of treatment with the Simpson Arc Light the suppuration ceased, the growth appears to have been inhibited, and the walls have, in parts, been covered by healthy granulations.

Case 1.—In one of those cases the patient had suffered for five years. The greater part of the side of the face and upper jaw had been destroyed by the disease. He had received various treatments at other hospitals. The cavity was lined with a nodular growth and was suppurating freely. Under treatment with the light from the Simpson arc lamp the ulceration improved rapidly. After three months, during which time he had forty-four treatments, the local condition was greatly benefited—suppuration ceased, and in many parts the cavity was lined by healthy epithelium.

Another case treated with good result is the following :—

Case 2.—The patient was aged 47. The ulcer was situated on the lower eyelid. It had been treated by X rays and had healed, but eleven months later it reappeared. When seen it measured $\frac{3}{4}$ inch by $\frac{1}{4}$ inch. Six applications of the light from the Simpson arc lamp were made during twenty-eight days. The focussed arc was used, and exposures of two and a half minutes were given. The ulcer healed and was covered by soft supple skin.

This patient was last seen on September 6th, 1915.

In the majority, however, of cases of malignant new growth the utmost benefit that has been produced has been a relief of pain.

B. *Lupus.*—Seven cases have been under treatment, one an old-standing disease affecting the tip of the nose and vestibules.

This patient has been under treatment off and on for three years. After sixteen applications the lupus was apparently cured.

The second case had extensive ulceration of the floor of the mouth, the tongue, gums, pharynx, larynx, and epiglottis. She had been under treatment with tuberculin, ionisation, etc., for two years, but without improvement. After thirty-three treatments with the light from the Simpson Arc Lamp the floor of the mouth was completely healed, the tongue, gums, and pharynx were better, the condition of the larynx unchanged.

The third case, in which the anterior part of the nose and septum were ulcerated, was greatly benefited by thirty-one treatments, extending over a period of five months.

The other cases have just commenced treatment, and appear to be making progress. Two cases of lupus, not ulcerated, have been treated successfully.

Case 1.—The patient, a girl, aged 5 years, had an area on the right leg, not ulcerated, measuring 2 inches by 2 inches. Thirty-two exposures to the light (open arc) were given over a period of sixteen weeks. The length of exposure was gradually increased till, at the end of eleven weeks, its duration was seven minutes. It was then gradually diminished to three minutes. The whole area of skin, after thirty-two exposures, looked quite normal, except for a slight pigmentation. The patient had previously received local medical treatment, but without avail.

Case 2.—The patient, a boy, aged 4 years, had a red area of skin over left malar bone, not ulcerated, edges slightly raised, spreading, not painful—first noticed five weeks previously as a small pimple. Twelve exposures of the light were given, from August 24th to September 28th, 1915. On the latter date all that was visible in the affected area was a small patch of red skin. Treatment was then discontinued, and on October 19th, 1915, the previously affected area was normal.

The open arc, two minutes exposure, was in this case employed in the first six treatments, afterwards the focussed arc was employed. One minute exposure.

C. *Syphilis and other Venereal Lesions.*—So far, we have only treated one syphilitic ulcer at St. Bartholomew's. The ulceration quickly improved, but the patient was also treated with mercury and salvarsan.

Major E. G. Ffrench, R.A.M.C., in *The Lancet* of January 29th, 1916, gives records of several venereal lesions treated successfully by the light from the Simpson Arc Lamp, in addition to the usual syphilitic remedies, and, after an extended experience, is of opinion that the addition of the light treatment definitely shortens the period of recovery. The scar-tissue, moreover, in cases thus treated, had a more healthy appearance than the ordinary scar-tissue after syphilitic ulcers. Soft chancres, under this treatment, healed rapidly, and destructive lesions of a phagedænic nature were arrested and healed without any marked deformity. Major Ffrench also found the light treatment to be of great benefit in cases of deep-seated suppuration of the inguinal glands. All packing was removed, and after each application of the light the lesions were protected by means of a fine mesh wire covering. The average treatment required for those suppurating glands was about nine applications.

D. *Eczema.*—Of this we have treated three cases—two on the hand, one on the dorsum of the foot. All have responded well to the light from the Simpson Arc Lamp. In all those cases the disease was attended with great itching.

Case 1.—The patient, male, aged 35, suffered from intense itching and pain in the fingers of both hands that had resisted other forms of treatment for nine months. The eruption was distributed on the dorsal aspect of the fingers and hands, and on both palms. Sixteen applications of the light were made over a period of twenty days. The open arc was used, and exposures of one minute each to the back and front of hand and fingers. Nothing was observed until the day after the fifth exposure, when the itching increased, and the discharge became more abundant. After a rest of three days the treatment was resumed daily. The itching and discharge then lessened, and on the twentieth day they had disappeared together with the eruption. This patient was last seen on October 4th, 1915, and promised to report any recurrence.

E. *Cases of simple infected Ulcers and Wounds.*—The ultra-violet light from the Simpson Arc Lamp has, in some cases treated, caused the rapid diminution of pain, swelling and suppuration, and has promoted the appearance of healthy granulations and quick healing.

F. *Cases of healing Wounds.*—The light seems to stimulate the healing of wounds.

All the above-mentioned are superficial cases. A few cases where the disease affected the subcutaneous, or deep parts, have been benefited.

It has already been mentioned that the ultra-violet rays penetrate the tissues scarcely at all. The possibility of affecting the deep-lying tissues by those rays may, therefore, be questioned. The mode of action of ultra-violet light on the tissues is, however, not understood, and it is certainly possible that the latter may be affected reflexly by stimulation of the peripheral sensory nerves, or in some other way.

Dr. William Benham Snow (*The Therapeutics of Radiant Light and Heat and Convective Heat*) says :—"The effects of radiant light and heat upon human tissue are complex from the nature of things, and not always easy of determination. . . . The induction of hyperæmia by the actinic effects of the higher frequencies, and from the combined action of all the frequencies of light, together with the radiant heat, are demonstrated to be capable of increasing positive chemotaxis, hastening the destruction and release of the tissues from deleterious substances, or forms of germ life present in them. The degrees to which this may be effected will vary with the character of the radiations as to volume and intensity. . . The application of intense heat and light to the peripheral neurons undoubtedly stimulates reflexly greater activities in parts and organs remote from the site of stimulation."

G. *Rheumatoid Arthritis.*—All our cases except one were of a very chronic type. Several of the patients derived much relief from pain, more especially when the disease affected the finger joints, though otherwise their condition was not improved. In the less advanced case referred to both knees were similarly affected, and both were treated in exactly the same way, by ionisation, the only difference being that, in addition the right knee had four minutes exposure three times a week to the light from the Simpson Arc Lamp for the period of one month. The right knee, thus treated, has improved so much more quickly, as regards the pain, swelling, and power of movement, than has the left, that, at the patient's request, the application of the light to the left knee has been commenced this week.

H. *Tuberculous Joints.*—

Patient, male, aged 45, carman, disease started three years ago, has been operated upon four times. When first seen, on September 16th, 1915, there were two discharging sinuses on outer aspect of elbow joint, about one inch apart.

After thirteen applications of the light (open arc—four minutes exposure) one of the sinuses was healed (November 7th), and has, up to the present time, remained healed. The other sinus healed on January 4th, 1916, after thirty-two applications, whereupon the patient ceased to attend, and resumed work. After fourteen days he returned to hospital, the sinus having again begun to discharge. Treatment was resumed, and the sinus ceased discharging on February 24th, since which date it has remained apparently healed. The last twelve applications have been made by the medium-focussed arc (exposure of three minutes each to external and internal aspects of elbow joint).

Other cases of tuberculous joints with sinuses have not improved.

I. *Tuberculous Glands in Neck.*—One patient, with considerable swelling of both sides of the neck caused by tuberculous glands (without sinuses), has been greatly improved, there being no evident swelling on one side, and a much diminished swelling on the other.

J. *Exophthalmic Goitre.*—One case was treated with apparent benefit. The patient, female, aged 43, was treated once a week by X rays, from June to September, 1915. The pulse rate under this treatment was reduced from 140 to 120, and the neck measurement from $13\frac{1}{2}$ inches to $12\frac{1}{4}$ inches. The patient complained of increasing dizziness after each X-ray treatment, so this was stopped, and, after a week's interval, treatment by the light from the Simpson Arc Lamp was begun. After nine applications twice a week (focal arc, two minutes exposure) the pulse rate was 96—tremor slight, and only in left hand—no palpitation or dizziness. The pulse rate on Dec. 21st was 80—there were no tremors nor palpitation nor dizziness.

On March 10th, when the patient reported herself, the pulse rate was 72—the tremors were hardly visible, the exophthalmos is much less marked—the neck measurement was $11\frac{6}{8}$ inches. The patient feels much better in her general health, and ascribes her manifest improvement to the light treatment.

She has had thirty-eight applications of the light.

Experiences with the Vapour: Asthma.—In the one case treated a definite improvement was obtained. The patient had suffered from severe asthma, nasal catarrh, and polypi for five years, during which time his disease had made steady progress. After forty-four inhalations of the vapour, during a period of four months, he was much improved in his general health, and was able to do full work. He had been practically free from attacks of asthma for the preceding six weeks, when he last attended hospital.

Nasal Catarrh and Sinusitis.—Three cases have received prolonged treatment of from three to six months, but without any definite results, except that the pain and discharge have been lessened.

Vaso-motor Rhinitis.—Two cases have been under treatment for a short length of time, and in both of them there has been a moderate degree of improvement.

Pulmonary Tuberculosis.—Up to the present time only one case has been treated at St. Bartholomew's Hospital. After sixteen treatments the patient says he feels much better and coughs less. It is, of course, too early to draw any deductions.

It is difficult at this early stage to gauge the potentialities of the application of the light from the Simpson Arc Lamp in the treatment of the different diseases, inasmuch as the exact mode of action, whether bacteriological or reflex, of phototherapy has not yet been fully determined. The first impression, however, of this recently introduced method of treatment is a promising one.

It is, moreover, easy of application, the exposure required with it is a short one, and so far I have seen no bad results.

I am indebted to Dr. E. P. Cumberbatch for kind permission to publish the notes of hospital cases under his care at St. Bartholomew's Hospital.

SOME OF THE PHYSICAL PROPERTIES OF ULTRA-VIOLET RADIATION.

In the diagram below is represented a chart of the wave lengths of radiations ranging from the visible part of the spectrum to X rays and the gamma rays of radium. The numbers across the top of the diagram represent the number of octaves which these rays range over ; the numbers across the bottom give their respective wave lengths in tenth-metres, *i.e.*, $_{10}{}^{-10}$ metre.

The limit of visibility at the red end of the spectrum is 7,594 tenth-metres, and is a convenient starting point for the purposes of this article ; the visible region of the spectrum is constituted by almost exactly one octave of radiation, the wave length of the rays corresponding to the extreme violet being very nearly one half that of the extreme red. Passing into the ultra-violet portion of the spectrum, it will be seen that rather more than two octaves have been investigated.

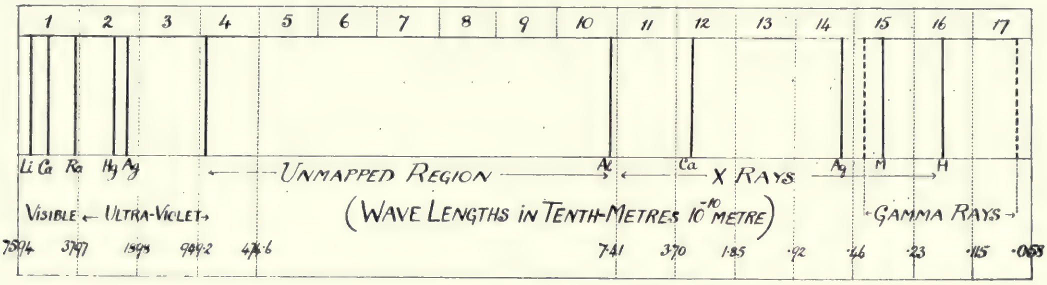


FIG. 1.

A region of about six octaves, which remains at present unmapped, separates the extreme ultra-violet from the commencement of very "soft" X rays. The most easily absorbed X rays, whose wave lengths have been determined, are the characteristic rays from aluminium, with a wave length of 8·4 tenth-metres. Passing up through several octaves of X rays, the limit indicated by the line H is reached. These represent the "hardest," *i.e.*, the most penetrating, X rays which have, so far, been produced. The line M represents an X-ray beam of "medium" penetrating power. The gamma rays from radium are represented in wave length as extending between the two dotted lines on the diagram, and it will be seen that the most penetrating gamma rays are of appreciably smaller wave length than the "hardest" X rays yet produced. On the other hand, some of the gamma rays are of longer wave length than "hard" X rays.

A few words may be said about the portion of the spectrum marked in the diagram "unmapped region." There are good reasons for believing that ether vibrations in this region, *i.e.*, of wave lengths ranging from 900 to 9 are very easily absorbed by matter, and this is no doubt, in part, the reason why the other properties of these vibrations have not yet been investigated.

Ultra-Violet Radiation.—Ultra-violet rays have been investigated over a range of rather more than two octaves. The first octave beyond the visible portion of the spectrum, with wave lengths from 3,800-1,900 A.U.,* is the region of therapeutic interest, for the radiation beyond this, and forming the second octave, is so easily aborted by air that investigation of it has to be carried out in a vacuum.

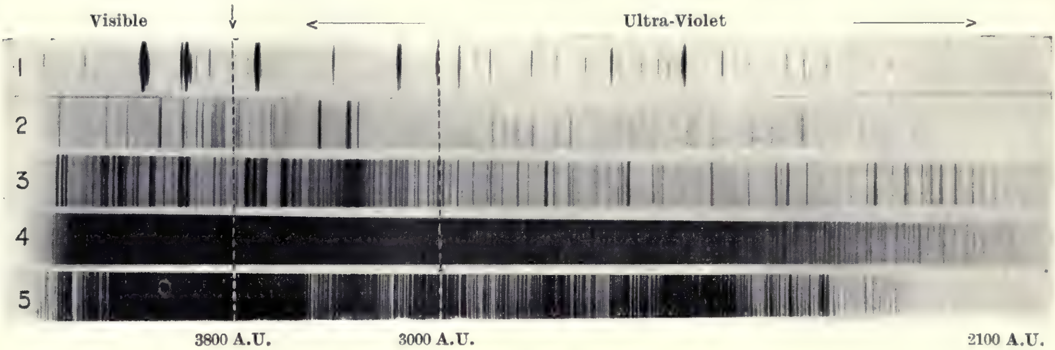


Fig. 2.—Sources of Ultra-Violet Light. 1. Mercury arc. 2. Silver arc. 3. Copper arc. 4. Simpson arc. 5. Iron arc.

In Fig. 2 are reproduced photographs of the ultra-violet radiation from various arcs taken by means of a quartz spectrograph. They are respectively (1) mercury, (2) silver, (3) copper, (4) the Simpson arc, and (5) iron. It will be seen that the spectrum of mercury vapour does not extend quite so far as that of silver, which, again, has not so large a range as copper. The Simpson arc consists of pole pieces of wolframite, the main constituent of which is tungsten. The radiation from this arc is very rich in ultra-violet rays, and an examination of it shows that it consists of a large number of emission lines which do not vary locally very greatly in relative intensity from one another, although the photographic intensity of the rays gradually fades off toward the region of short wave lengths. The general character of the spectrum of the Simpson arc appears, therefore, to be one rich in ultra-violet radiation, which is graded fairly uniformly throughout the region under consideration ; this is in marked contrast to the arc spectrum of copper, which is seen to consist of groups of very bright lines, with considerable intervals between them. The iron arc (5) is also seen to be a rich source of ultra-violet radiation.

The Penetrating Power of Ultra-Violet Light.—When any of the various sources of ultra-violet light are used therapeutically the question arises as to how far the rays are able to penetrate through the tissues. It has long been known that blood pigments are strongly absorbent of such radiation, and means were accordingly taken to prevent, as far as possible, direct access of the blood to the part receiving the rays.

It seemed desirable, however, to make some measurements of the extent to which the ultra-violet rays penetrate the skin. For this purpose skin removed from the human abdomen was used ; it was cut parallel to the external surface in layers $_{10}$mm., ½mm., and 1½mm. thick by means of a large-sized microtome ; these different thicknesses of skin were then placed in front of the slit of the spectrograph, to ensure that any radiation entering the instrument and affecting the photographic plate placed in position, would first have penetrated the particular thickness of skin.

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* A.U., that is, Angstrom unit, is one-tenth metre.

The source of ultra-violet radiation selected was the Simpson arc. When this was placed about 20 cm. distant from the slit of the spectrograph an exposure of a few seconds was sufficient for a photograph of this radiation as far as wave length 3,000. In order to bring out the very short wave lengths the plate has to be rather over-exposed in the violet region (see Fig. 3, No. 1). The exposure in this case was 5 seconds.

Fig. 3.—Absorption of Ultra-Violet Light by Human Skin. 1. Unscreened radiation from the Simpson arc ; exposure 5 seconds. 2. Screened by one-tenth of a millimetre of skin ; exposure 2 minutes. 3. Screened by one-half of a milllimetre of skin ; exposure 8 minutes. 4. Screened by one and a half millimetres of skin ; exposure 8 minutes.

It was soon found that skin was very absorbent for the ultra-violet radiation, and consequently the time of exposure had to be much increased in order to obtain any record on the photographic plate. Fig. 3, No. 2, shows the result of interposing $\frac{1}{10}$ mm. of skin in front of the slit of the instrument ; the exposure was increased from five seconds to two minutes. No. 3 and No. 4 show the results for a thickness of $\frac{1}{2}$ mm. and $1\frac{1}{2}$ mm. respectively ; the exposures were in each case eight minutes—that is, nearly one hundred times that of the unscreened radiation. In spite of this, however, a large portion of the spectrum is cut out.

It will be seen, therefore, that ultra-violet rays of wave lengths 2,100 to 3,000 A.U., the approximate positions of which are indicated in Fig. 2, are very easily absorbed by human skin ; certainly less than one part in a thousand of this radiation penetrates to a depth of half a millimetre.

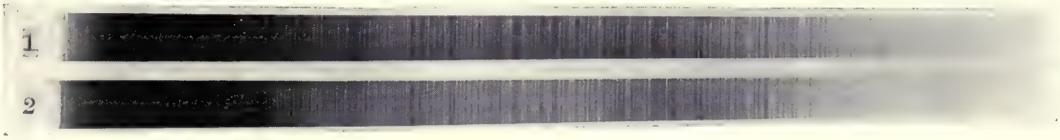

Fig. 4.—Ultra-Violet Spectra of Simpson arc and Pure Tungsten arc. 1. Simpson arc. 2. Pure Tungsten arc.

As we proceed to the region of wave lengths 3,000 to 3,800 A.U., which latter marks the onset of visible radiation, the rays become rather more penetrating, but it is doubtful whether as much as 1 per cent. of the radiation penetrates as deep as 1 mm. Fig. 3, No. 4, shows, however, that a small percentage of ultra-violet radiation penetrates $1\frac{1}{2}$ mm. of human skin.

The Spectrum of the Simpson Arc.—The poles of the Simpson arc are said to consist of wolframite, a prominent constituent of which is tungsten.

In order to see to what extent tungsten contributes to the ultra-violet radiation from the Simpson arc, two electrodes of pure tungsten were obtained, and the arc spectrum photographed in the same way as indicated above for the Simpson arc.

In Fig. 4, No. 1 is a photograph of the spectrum of the Simpson arc, between wave lengths 5,800 and 2,100 A.U. No. 2 is a photograph of the spectrum of a pure tungsten arc over the same region; the exposures were for five and ten seconds respectively.

Inspection shows that the two spectra are apparently identical. Whether there are differences in the relative intensities of the emission lines cannot be said without a more extensive examination.

Comparison between the Carbon Arc and the Tungsten Arc.—For the purposes of comparing the radiation from carbon and tungsten arcs photographs were taken on the same plate and under similar conditions of exposure. Fig. 5, Nos. 1 and 3, are photographs of the carbon arc, the exposures being twelve and six seconds respectively. Nos. 2 and 4 are photographs of the tungsten arc under similar conditions. It will be observed that the two photographs of the tungsten arc are very much over exposed, except in the region of very short wave lengths. It is not possible from these data to state how much more intense the radiation from tungsten is than that from carbon, for the mode of distribution of energy throughout the two spectra is not identical.

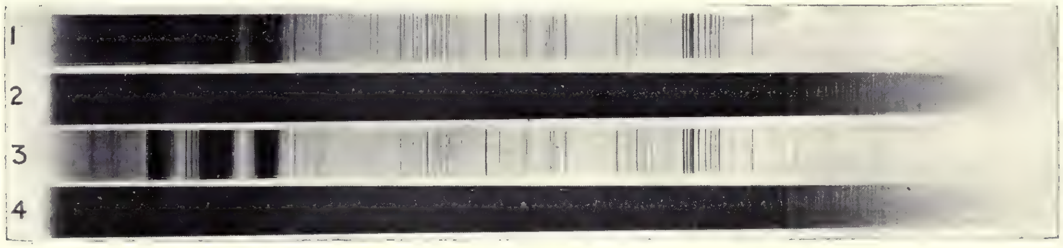

Fig. 5.—Nos. 1 and 3, Spectra of Carbon Arc. Nos. 2 and 4, Spectra of Tungsten. Length of exposure the same in the two cases.

Sidney Russ.

REPORT OF SOCIETY.

AMERICAN ELECTROTHERAPEUTIC ASSOCIATION.

Twenty-Fifth Annual Meeting, held at Atlantic City, N.J., September 14-15, 1915.

Dr. George E. Pfahler, Philadelphia, claimed that since three-fourths of the patients with cancer of the breast came for operation, only after the disease had spread from its original source and involved neighbouring glands, that most of them could not expect to get well from surgery alone. Since cancerous tissue had been shown repeatedly to disappear as a result of X-ray treatment, even where far advanced, it could more surely be made to disappear if applied immediately after operation. The rays would help to prevent the spread of the disease, and would do much toward preventing its recurrence. At least 25 per cent. more patients could be got well of cancer of the breast if every patient were treated properly by the X rays after operation. It was just as important to have this X-ray work properly done as to have the surgery properly done.

Dr. J. D. **Gibson**, Denver, reported 757 cases of pulmonary tuberculosis which he had treated during the last fourteen years with X rays. Of these, 102 had been lost sight of, 566 were living to-day, and 91 were known to be dead. These cases consisted of 96 first stage cases, 343 second stage cases, and 318 third stage cases. Thirty of those that were reported dead had received less than two months' treatment. The author emphasized the importance of early diagnosis. Even before tubercle bacilli were found in the sputum, cases should be diagnosed by means of roentgenograms, physical examination and clinical history. Every case discovered in the prebacillary stage was positively curable by means of the ordinary method of treatment, with the addition of the X-ray and ozone. The author claimed that by this method the physicians of the United States could eliminate tuberculosis as a factor in the death rate. In other words, in ten years, by applying these principles, the death rate from tuberculosis could be made less than that from small-pox at the present time.

Dr. A. B. **Hirsh**, Philadelphia: He held that differentiation of varieties of arthritis was of minor value for the electrotherapist, as the treatment was uniform for them all. An accurate diagnosis, to exclude other joint diseases, was a *sine qua non* for success. He divided the treatment into (1) removal of the causative centre of infection; (2) improvement of the general nutrition, and (3) direct applications to each affected joint for a return, as far as possible, to normal condition. Beside static, sinusoidal and continuous currents, a corrected dietary, together with radium emanation water and with stock and autogenous vaccines, as adjuncts, were indicated. When faithfully carried out, these would lead, as a rule, to removal of the disease.

Dr. **William Benham Snow**, New York, in discussing hyperthyroidism and its treatment, said the method he employed was the combined use of static wave current, X-ray and mechanical vibration. The electrical current reduced the gland by forcing out accumulated colloid and effete matter. The X-ray effectively inhibited or lessened the excessive secretion of the thyroid gland, the disturbing factor. Mechanical vibration applied over the proper intervertebral spaces aided by contracting the arteries, thereby to a degree diminishing the excess secretion. Dr. Snow claimed for the method uniform success, even in extreme cases, without danger or inconvenience to the patient. The disturbing heart symptoms were permanently corrected; there was a return to health, with prompt increase in body weight, and the ophthalmic symptoms improved under the combined method.

Dr. **Herbert F. Pitcher**, Haverhill, Mass., made a plea for the intelligent use of the static machine. The well meaning physician who laid aside a good static machine, lost one of the most valuable therapeutic agents in existence. No instrument required more study and knowledge, and there was none which would give richer returns when employed in a scientific manner. The author emphasized the importance of keeping the machine dry and clean.

Dr. **Frederic de Kraft**, New York, after reciting the various causes of headache, called special attention to the uses of electricity in the treatment of toxic headache. By the use of the high frequency current the blood could be heated to such a degree that the smaller blood vessels in the skin and mucous membrane became widely dilated. As a result of this rush of large volumes of blood to the periphery for cooling effect, relief of venous engorgement in internal organs was effected. Renewed activity occurred resulting in an improvement of elimination. Dr. de Kraft also called attention to the mechanical effects of the static wave current, the static induced and the sinusoidal current. When employed with large electrodes over the abdomen and over the dorsal and lumbar region, these modalities might be depended upon in restoring the tone of both voluntary and involuntary muscular fibre. This would bring about improved vascular tone and removal of venous stasis in the splanchnic area. As a result of the improvement in the activity of the organs of elimination greater freedom from toxic elements in the blood was secured. He also called attention to the general oxidising and pain relieving effects of the static brush discharge. A judicious combination of the use of these electrical modalities, together with exercise in the open air and regulation of the diet to suit the needs of the system, would result in the removal of periodical toxic headache in a very large number of cases.

Dr. A. W. Yale, Philadelphia, discussed the pathology of dilatations of the aorta, the importance of the use of the fluoroscope as an aid in diagnosis, and the sphygmomanometer readings. He advocated treatment with the static condensed current followed by vibration of the seventh cervical interspace, and reported cases treated by this method.

Dr. William T. Johnson, Philadelphia, in discussing thrombo-angeitis obliterans, said this was a thrombotic process, which occurred in both arteries and veins, usually in the lower extremities, probably caused by some microbial agent. The failure in nutrition went on to gangrene, and amputation became imperative. The treatment consisted in applying the high frequency current by the diathermic method, one suitable electrode being placed over the toes, which must be properly protected, and the other on the limb at a point above the manifestations of the disease. Great care must be taken to avoid burning. The current strength was largely determined by the sensations of the patient, although it was best not to exceed 500 milliampères. Daily treatments should be given over a period of some months. A well marked case treated in this way was symptomatically well after eight months of treatment.

Dr. William Martin, Atlantic City, reported a case of polyneuritis of motor type. The etiologic factor was of a virulent toxic type, at the time thought to be uremic, occurring at mid-term of pregnancy. Evacuation of the uterus stopped seizure, but left patient with a practical paralysis of the voluntary muscles and some loss of organic functions. Loss of motion and sensation in legs was complete. Treatment was by use of static wave over the spine, sinusoidal and interrupted constant current, alternated, in labile manner, applied to affected parts. Spinal vibration and vibration to motor points were added to the above. The patient made a complete recovery.

NOTICES.

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ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY

(*Archives of the Roentgen Ray*)

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TUBERCULOSIS OF THE BONES AND JOINTS.

By R. W. A. SALMOND, M.D., Ch.M., Assistant Radiographer, King's College Hospital, Capt. R.A.M.C. (T.).

(*Continued from page* 378.)

Knee Joint.—The disease may start in the femur, tibia, patella, synovial membrane, or fibula. Owing to the size of the joint and its proximity to the surface any unusual contents are clearly shown, especially in the lateral view. The patella generally shows a markedly irregular outline.

Differential Diagnosis :—

Hydrops articuli.
Schlatter's Disease.
Bleeder's knee.
Rheumatoid arthritis.

Figs. 9 and 10 show a case of primary bone origin. Rarefaction is present, and the focus of disease, now an abscess cavity involving both sides of the epiphysial line, with some sclerotic osteitis around it. There is slight irregularity of the articular margin of the femoral epiphysis. A small sequestrum is seen lying at the lower and posterior aspect of the abscess cavity, but the joint is not yet involved.

Figs. 11 and 12 are from the same case twelve months later, when the disease had progressed considerably. Very marked rarefaction is now present, the cavity has increased in size and its sequestrum extruded. The joint has become infected, as seen by its increased density and distended appearance, while the patella and articular margins show a good deal of irregularity.

Ankle Joint.—This is chiefly affected during adolescence, the site of origin being in the astragalus, tibia, synovial membrane, or the fibula. The rarefaction involves the whole of the bones of the foot, and the joint, if not affected primarily, generally soon becomes involved and shows a distended outline. The bony margin of the tibial epiphysis becomes irregular and may disappear, and similarly the articular surface of the astragalus becomes irregular, and is ultimately absorbed. The disease may spread through the astragalus to the other tarsal bones and joints.

Differential Diagnosis :—

" Sprained Ankle."

Fig. 13 is from a case of well advanced disease and shows most of the appearances just mentioned.

Tarsal Bones and Joints.—The disease may start in any of the bones or synovial membranes, or it may be secondary to disease at the ankle joint. The most frequently affected bones are those nearest that joint, and owing to the communications of the synovial membranes of the numerous articulations, there is a great tendency to spread. The os calcis is often affected just in front of its epiphysial line, and then usually shows no tendency to spread to the neighbouring joints. As in the carpus, old standing cases often show a thickened cortex, but this appearance is not confined to this disease.

Differential Diagnosis :—

Flat Foot.

Fig. 14 shows a comparatively recent focus in the scaphoid bone with some rarefaction of all the others.

Metatarsus, Phalanges and Joints.—Compared with the corresponding parts of the hand, these are much less frequently affected and present the same appearances.

Sterno-Clavicular Joint.—The appearances are similar to the other joints.

Shoulder Joint.—This is one of the larger joints which is less frequently attacked, and when so, it is usually after childhood. The origin is usually osseous, the head or greater tuberosity of the humerus or the neck of the scapula, but it may start in the synovial membrane. Here the so-called caries sicca often occurs, that is, when the bony tissue is slowly eroded without abscess formation, and the bone and surrounding soft parts show marked

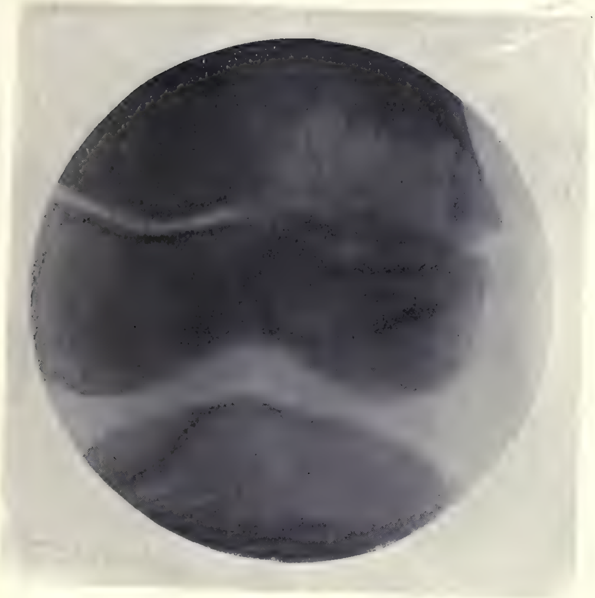


Fig. 9.

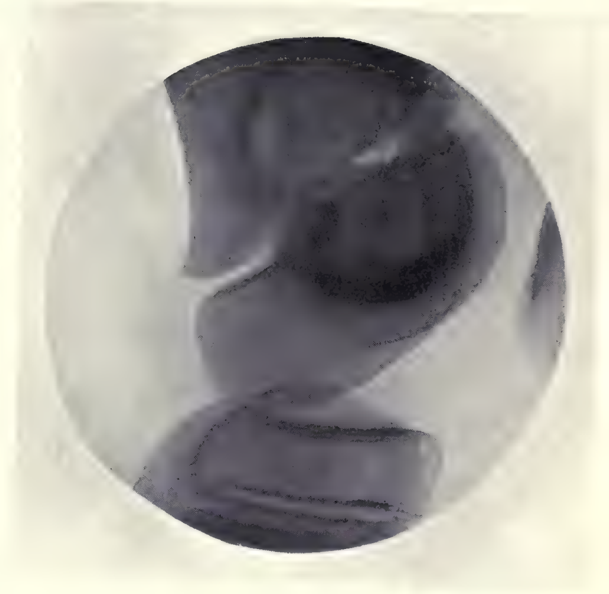


Fig. 10.

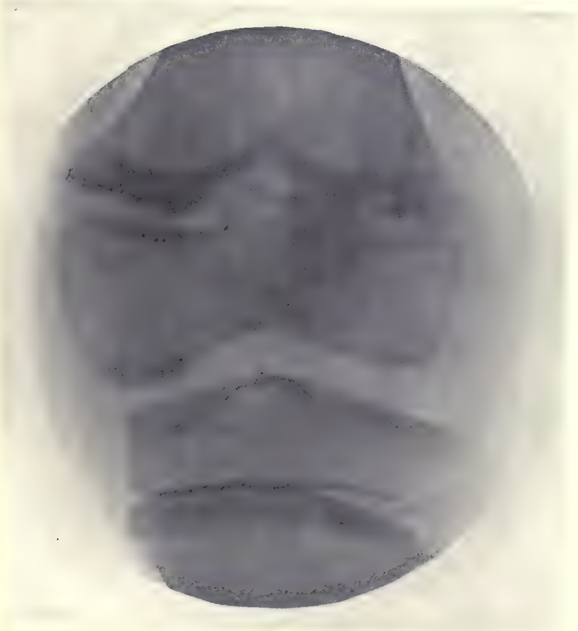


Fig. 11.
Same case as Figs. 9 and 10. 12 months later.

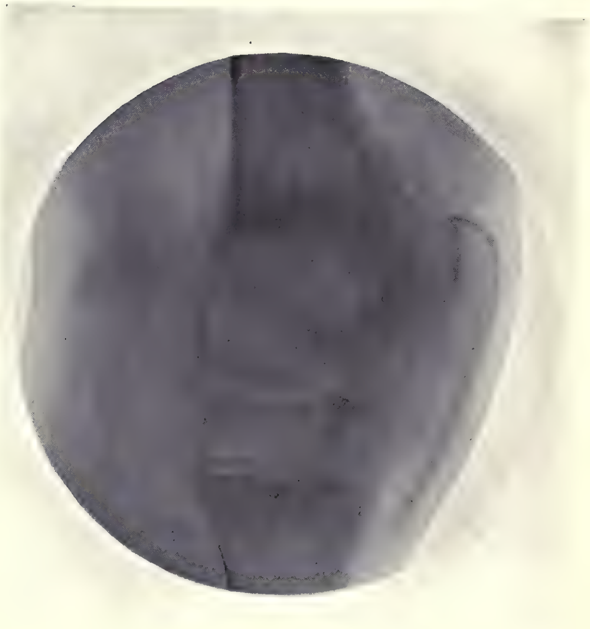


Fig. 12.
Same case as Figs. 9 and 10 taken 12 months later.

TUBERCULOSIS OF THE BONES AND JOINTS.
By R. W. A. Salmond, M.D., Ch.M.

Plate 38.

atrophy. At other times, abscess formation takes place as in the other joints. Another characteristic of the disease here is that it is often accompanied by disease of the lung. This is probably not due to direct spread from the one to the other, as the case of caries sicca of the head of humerus shown in Fig. 15, was accompanied with marked phthisis of the *opposite* apex.

Fig. 16 shows another case of this type, and in this there was chronic pulmonary tuberculosis at both roots.

Differential Diagnosis :—

Rheumatoid arthritis.
Subacromial and subdeltoid bursitis.

Elbow Joint.—The disease may start in the humerus, olecranon, head of radius, or in the synovial membrane, osseous origin being the more frequent. The progress of the disease is as elsewhere, the ends of the bones becoming eroded and absorbed. so that shortening and contracture of the limb occurs. Periostitis of the shaft of the humerus is very frequently present.

Fig. 17 shows an advanced case. The articular cartilages have been destroyed, as seen by the absence of space between the ends of the bones. The latter are very irregular, especially those of the forearm, while marked periostitis is seen along the shafts of all three bones. The fluffy appearance in the soft parts indicates the amount of inflammatory infiltration into these tissues, while the outline of the elbow shows the typical clinical appearance of the disease here. This case also shows the value of a soft tube in bringing out detail, as another negative taken with the tube in ordinary use proved very disappointing, though of course quite diagnostic.

Wrist Joint.—The disease is found here chiefly after childhood. It may start in any of the bones entering into the joint, especially the radius, or in the synovial membrane. Rarefaction is usually well marked, and the condition of the joint, being close to the surface, well seen. Owing to the arrangement of the synovial membranes, the disease frequently spreads through the carpal bones to the metacarpals, one or more of the carpus often being completely destroyed. In old standing cases the cortex of some of the carpal bones often becomes thickened, but this is not confined to tubercular disease.

Fig. 18 shows the rarefaction of the bones and appearance of increased density of the joint in a case starting in the synovial membrane.

Fig. 19 shows the same case twelve months later. The rarefaction has increased, and there is an abscess cavity at the lower end of the diaphysis of the radius. Some periostitis is present along the shafts of the metacarpals, and the destructive effects of the disease on some of the carpal bones seen as well as their thickened cortex.

Other Carpal Bones and Joints.—The relation between these and the last mentioned joint is so intimate that no separate description is necessary.

Metacarpals and Phalanges.—Here the disease presents some special features. The cases may be divided into two classes :—(1) where the shaft, (2) where the joint, is involved.

(1) Disease of the shaft is the more common, and is the form usually met

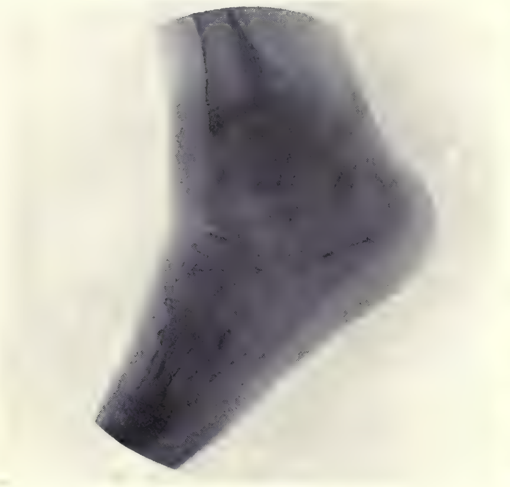


FIG. 13.

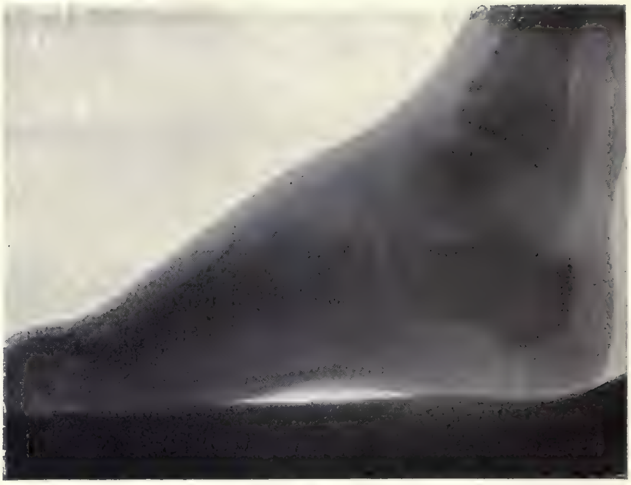


FIG. 14.

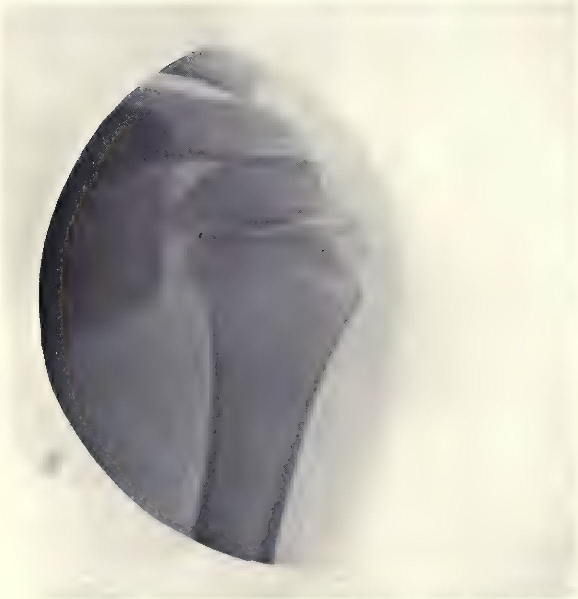


FIG. 15.

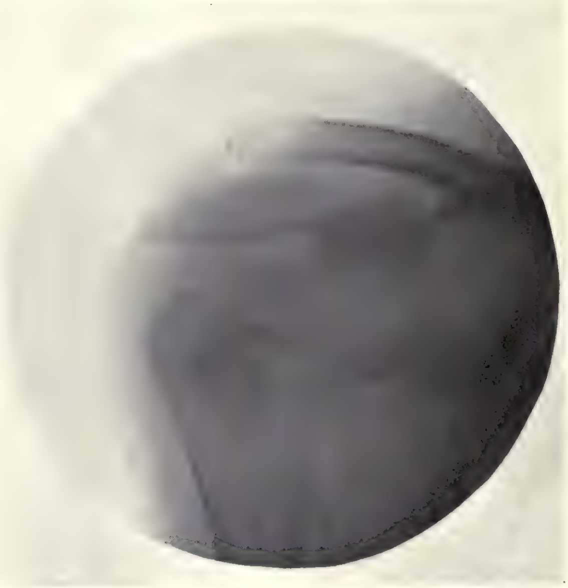


FIG. 16.

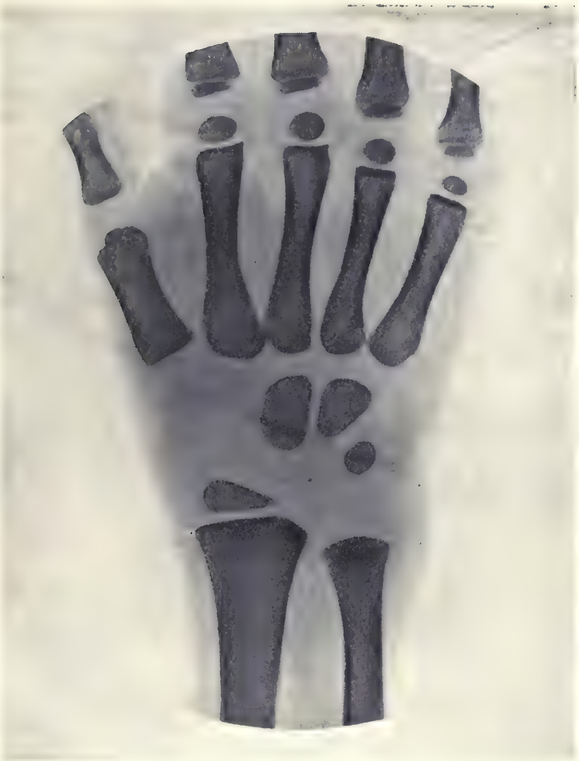


FIG. 18.

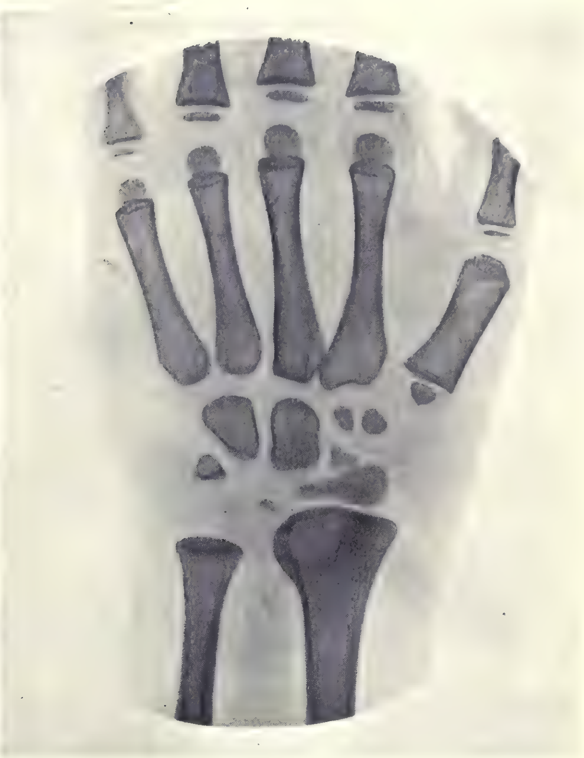


FIG. 19.
Same case as Fig. 18 taken 12 months later.

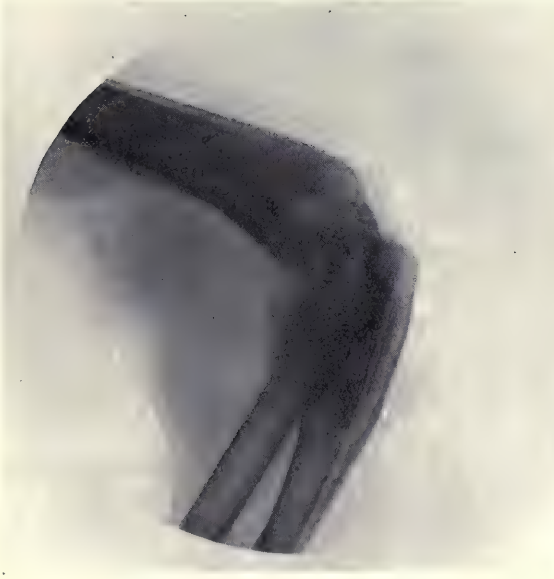


FIG. 17.

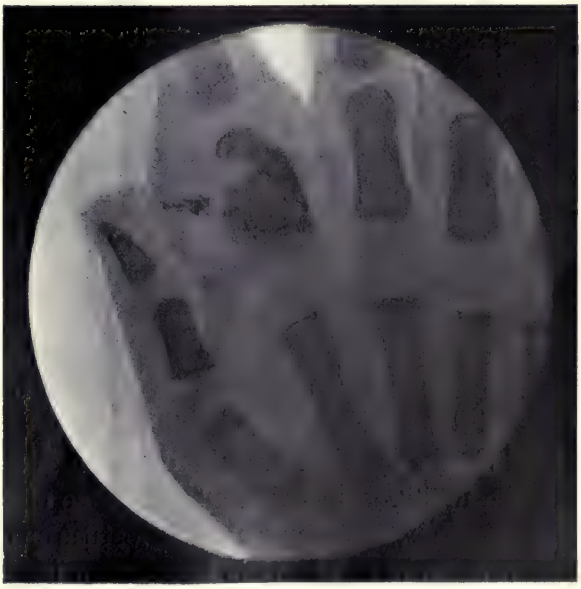


FIG. 20.

with in young children. A small translucent focus appears in the interior of the shaft and enlarges, usually causing the bone to expand so that it looks blown out (spina ventosa). Its interior shows a thinned appearance from absorption of the trabeculæ, and the periosteum may show thickening and separation from the shaft. The joint is not usually affected in this form. The thinned bone may break, presenting the appearance of a fracture in a cyst wall. Abscess formation, if it occurs, shows as an increased shadow in the soft parts on the negative, often containing a piece of unabsorbed bone. This form does not commonly commence after the first three years of life (important in diagnosis from syphilis), and two or three bones, not necessarily on the same finger, are usually affected concurrently.

Differential Diagnosis:—

Syphilis of the Phalanges of the fingers.
Bone Cyst.
Enchondroma.

Fig. 20 shows the blown out appearance of a phalanx in this type of the disease and the corresponding deformity of the soft parts. The interior has broken down into pus, and this was being discharged through a sinus on the surface.

At other times the disease presents the appearance of a periostitis, and then generally in adults.

At other times, a small translucent focus appears in the base of one of the metacarpals ; and remaining localized, breaks down into an abscess cavity.

(2) Joint infection is the form seen generally in adults, though it also occurs in children. The primary focus may be bony, or synovial, and the appearances are similar to those seen in the larger joints.

TUBERCULAR DISEASE OF BONE DISTANT FROM THE JOINTS.

This is less common, and the value of X rays in diagnosis somewhat less, and, on the whole, the appearances are like those already described, so that it will be sufficient to briefly mention the more frequently affected parts.

Skull.—The frontal and parietal bones may be affected, the disease starting in the diploë or the periosteum.

Differential Diagnosis ;—

Syphilis.
Secondary malignant disease.

The malar bone, orbital margin of superior maxilla, and the angle of inferior maxilla are the most frequent sites, while the mastoid process may be involved in tubercular disease of the ear.

Ribs.—It starts as a periostitis or more rarely in the interior. In the former, erosion of the bone is seen as an irregularity of its outline ; this increases and invades the deeper bony structure, while the presence of an abscess in the soft parts may be seen.

In the latter, it expands the bone as in the phalanges.

Sternum.—It may start as a periostitis or in the interior, and is usually best seen in a true lateral view.

Clavicle.—It starts usually at the outer end as a periostitis or an osteomyelitis, as in the ribs.

Scapula.—The acromion process, in addition to the parts entering into the shoulder joint may be affected.

BOOKS OF REFERENCE

Tuberculous disease of bones and joints. Sir W. Watson Cheyne.
Joint Tuberculosis. Leonard W. Ely.

SOME NOTES ON THE X-RAY DEPARTMENT OF THE SCOTTISH WOMEN'S HOSPITAL, ROYAUMONT, FRANCE.

BY AGNES SAVILL, M.A., M.D. Glasgow, M.R.C.P. Ireland.
Physician London Skin Hospital, Fitzroy Square.

ON the outbreak of European war the National Union of Women's Suffrage Societies decided to throw aside all its usual propaganda, and to devote its entire energy and resources in human activities and wealth to the assistance of the nation in its hour of supreme need. The Scottish branch, at the instigation of Dr. Elsie Inglis, outlined a scheme for two hospitals, each of 100 beds, to be worked by medical women, and offered the services of these units to the Scottish Red Cross authorities and also to the War Office. At that time the British Army was adequately supplied with medical aid, and Dr. Inglis was advised to place her plan before the French and Serbian allies. The proposed hospitals were welcomed by our allies, and from this modest beginning the "Scottish Women's Hospitals," as they were named, developed until, by the autumn of 1915, they had organised, financed, and maintained over a thousand beds in Serbia and France. The first French unit was stationed at the Abbaye de Royaumont, some twenty-five miles behind the firing line, where it did such good work that within a few months the French military authorities requested it to double its beds.

A description of some of the difficulties experienced by the X-ray worker may interest those who may be or have been situated in similar circumstances in a foreign country.

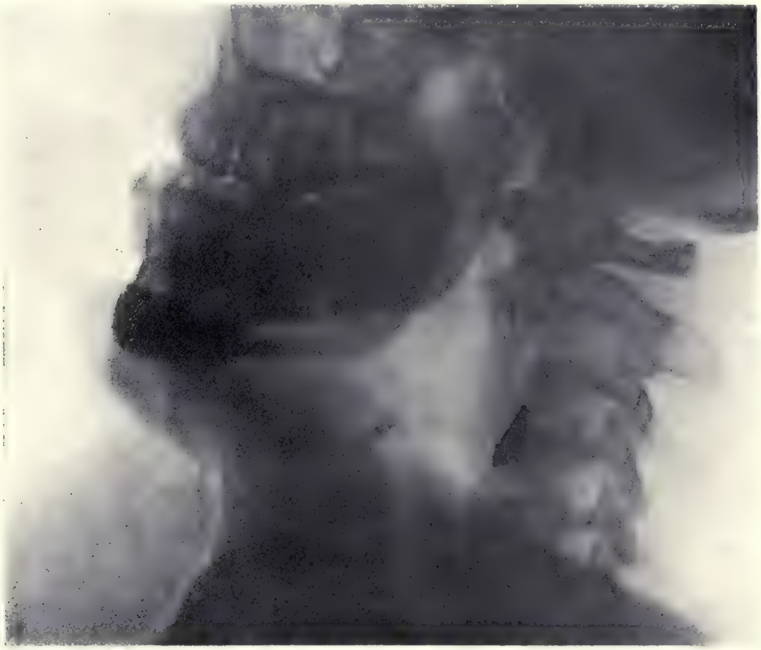
The Abbey was a most beautiful building, but for the purposes of a hospital it was much too large and rambling. It was obvious that without much careful forethought and planning a fortune might be spent in modernising its vast halls and corridors. The building had been a centre of learning and a fashionable retreat for many centuries, until at the Revolution the cathedral in its grounds had been destroyed and the monks expelled. The Abbey had then been converted into a cotton factory, which flourished until, about 1860, it again became the home of a religious community. This time it was a community of nuns, who in their turn were obliged to go. For nearly ten years the Abbey remained uninhabited, and the dust and damp of a decade had to be removed before the beautiful arched rooms could be employed as wards. The beauty and charm of the place were so potent that no member of the unit, even for a moment, contemplated that the work of modernising it for use as a military hospital could be regarded as impossible.

An X-ray room was fitted up on the first floor, close to the operating theatre. No *developing* room could be found on the same floor; and only a large cupboard was ultimately available on the ground floor. The cupboard had no water supply; but with a fish-kettle filled with water it was not difficult to obtain excellent results. For the final washing the photographs had to be carried upstairs to a washing sink. In spite of all these troublesome processes the developing was easily performed until there came a rush of work, with a hundred photographs a week. Then a village plumber, who had known the Abbey in the days of the nuns, found for us an unexpected cold water pipe in a cupboard on the first floor. This space was promptly fitted up as a developing room, and thus the apparently insuperable obstacle was quickly solved. The experience of the first months, however, has rendered me most unsympathetic with young workers who say it is impossible to work well without all the luxuries and conveniences to which a training in a medical school has made them accustomed.

Electrical energy was available to supply a limited number of lamps for illuminating the wards and theatre; but there was not sufficient for running the X-ray from the main. One set of 36 ampère-hour accumulators was placed in the X-ray room. A charging board was fixed close to the accumulators, so that the cells were never subjected to the constant movement entailed when the charging has to be carried out at a distance.

Accumulators as a source of energy are frequently decried. At first I could obtain no information regarding their care, which would enable the department to have sufficient output at all hours and days from one set of accumulators. The building was supplied with electric light, but the source of the supply was much too limited to permit of the passage of sufficient ampèrage for the X-ray room. Moreover, it was often turned off during the day, so that it was in any case inadvisable to use it as the generator for X-ray work which had to be performed during the day. Some of the early photographs were carried out with a current of only one-third of a milliampère, and even less. The time of exposure was certainly prolonged, but to my surprise the radiograms were satisfactory. Eventually I found that the accumulators yielded good and constant results when they were charged for a time every day. A daily charge was given until hissing of the acid was audible. The utmost current obtainable through a medium tube was one and three-quarter milliampères, but by employing small hard tubes the screening was as clear as is usually associated with a current of three or four milliampères. The cheaper tubes lasted longer than the more expensive ones, such as the Macalaster Wiggin tube; probably because one to two milliampères is a normal current for the small tube, whereas on the larger heavy anode tubes it appeared to have an unduly hardening effect.

At the beginning of the war much was said as to the inadvisability of extracting foreign bodies which were causing no trouble. It was soon apparent that the problem lay in deciding which objects "gave no trouble." Again and again we found that foreign bodies, apparently long quiescent, would one day become the centre of a troublesome abscess. Sometimes the abscess would bring the foreign body nearer to the surface, and thus facilitate the work of the surgeon; but almost as often the abscess led to deep-seated complications. Two such apparently simple cases made a deep impression. One was that of an arm containing seven small pieces of shell. Two were readily extracted; the others were so small and deep-seated that it seemed unwise to endeavour to find them. It was considered that they would become encapsuled and harmless. Two of these, two months later, gave rise to deep-seated abscesses and secondary hæmorrhage. The other case was that of a young man who had been wounded in the first month of the war. His wounds had healed and he had returned to the firing line. After several months he was invalided owing to extreme pain in the site of the old wounds. He came then to our hospital, where it was discovered that he was suffering from deep-seated abscesses in the vicinity of the foreign bodies which had been allowed to remain in the muscles of his thigh a year previously.



Case 1.—Fractured Lower Jaw. Piece of shell lying on cervical vertebrae.

Bacteriological research has provided an explanation of these surprising clinical facts, by showing that in this war the portions of shell which are deposited in the tissues are usually infected with one or more pathological organisms. If the piece becomes encapsuled and apparently innocuous, it may, at some future date, after movement or other causal factor, become an active source of septic inflammation. At Royaumont it was the practice to cleanse the wounds immediately on arrival and extract any foreign body when there was a direct track leading to it from the wound. If the object was not easily found, without incisions which could carry infection to fresh tracks, it was permitted to remain *in situ* until the wound was healed. As patients frequently arrived within twelve hours after injury, many foreign bodies were extracted on the same day.

Even when sepsis was not set up by old embedded portions of shell, the men frequently complained of pain which rendered them useless as soldiers until the objects were extracted. Cases 3 and 4 illustrate that point very notably.

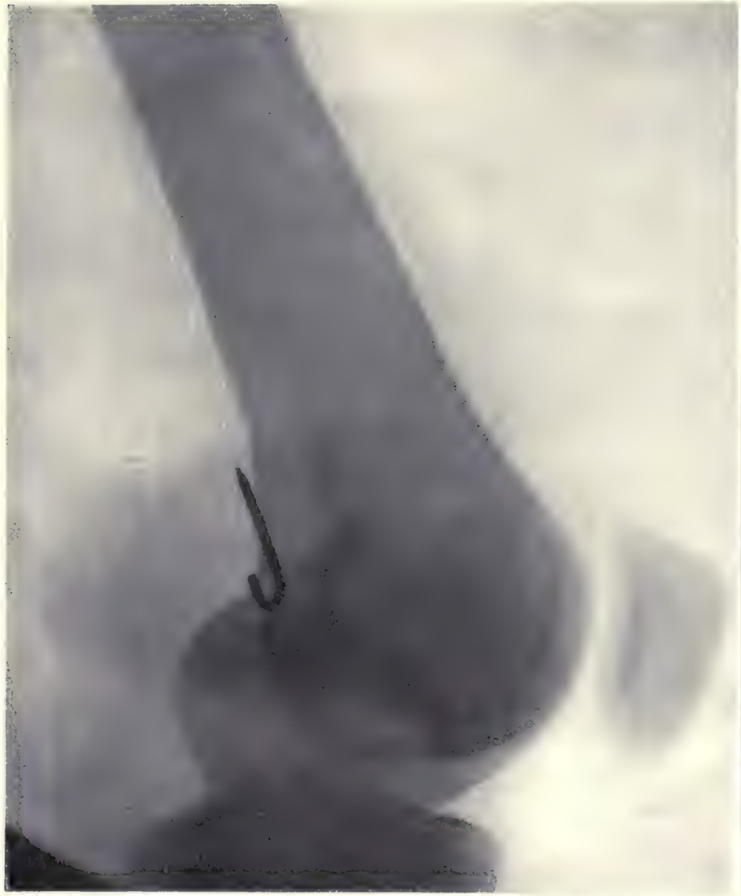
Some of the difficulties met with in localisation of foreign bodies may be mentioned here.

The majority of the cases of localisation were carried out by Hampson's modification of Mackenzie Davidson's triangular method. The tube is first carefully centred so that the foreign body lies exactly in the central beam of the rays. The diaphragm is cut down to enable the operator to mark accurately a selected point of the foreign body which lies in this central ray. The mark may be made on the skin or on the screen. The tube is then displaced to one side, the diaphragm widely opened, and the same point of the object is marked. The distance between the marks is measured with the utmost precision, the distance from anticathode to the first mark is noted, and by the simple calculation which has already been described in the ARCHIVES by Dr. Hampson and by Dr. Thurstan Holland, the depth of the foreign body is readily ascertained.

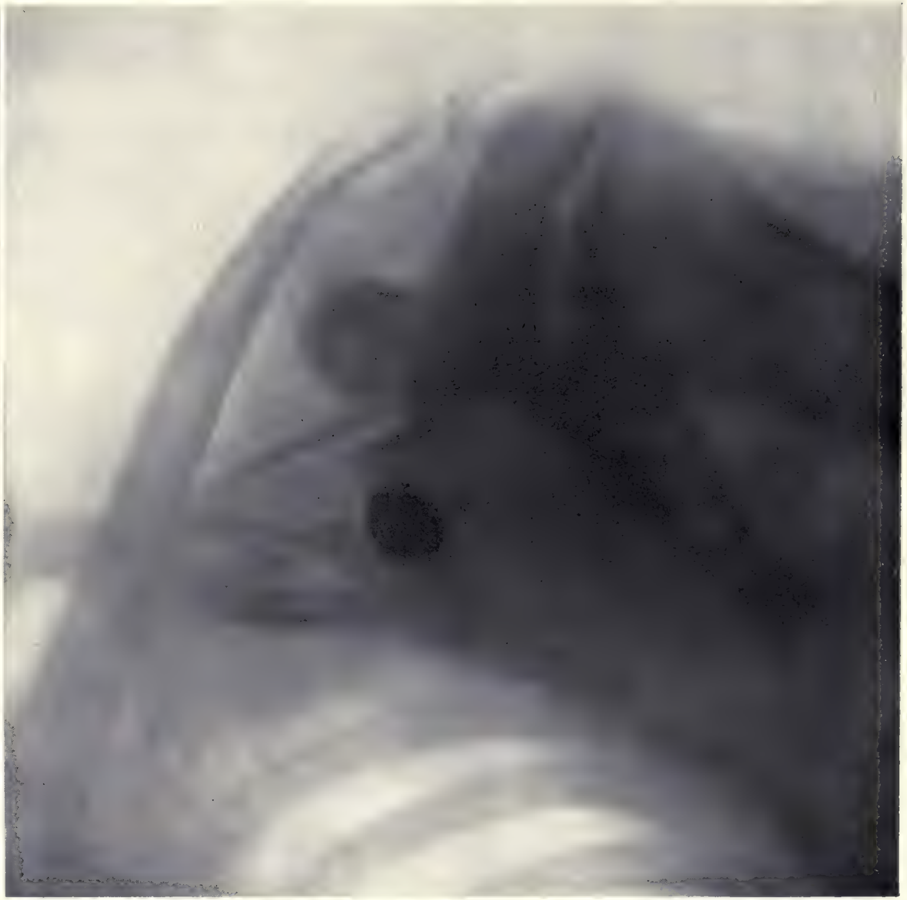
Much difficulty is often experienced in estimating the exact distance between the two marks on the skin. The slightest error in this measurement throws out the final calculation. The operator must therefore be certain to choose the same point of the image on the two occasions of marking. This is by no means always easy, and is a fruitful source of error.

Another unexpected difficulty was the marking on the skin. As the distance between the two marks must be measured accurately to a millimetre, it is obviously of importance to employ a marker which leaves only a very fine impression. All the markers which I have seen imprint much too broad a dot. This leads to errors in estimating the distance between the marks, because it is forgotten which side of the dot represents the selected point of the image. I obtained the best results by the tedious process of passing a metal probe under the screen and holding it firmly in position while an assistant turned on the light, removed the screen, and with a fine pen made a dot on the skin.

In measuring the height of the mark from the anticathode extreme accuracy is not necessary. As Thurstan Holland has pointed out, even a difference of three or four centimetres makes a negligible difference in the final result of the calculation.



Case 2.—Hand Grenade Wound. Nail close to popliteal artery.



Case 3.—Shrapnel Bullet.

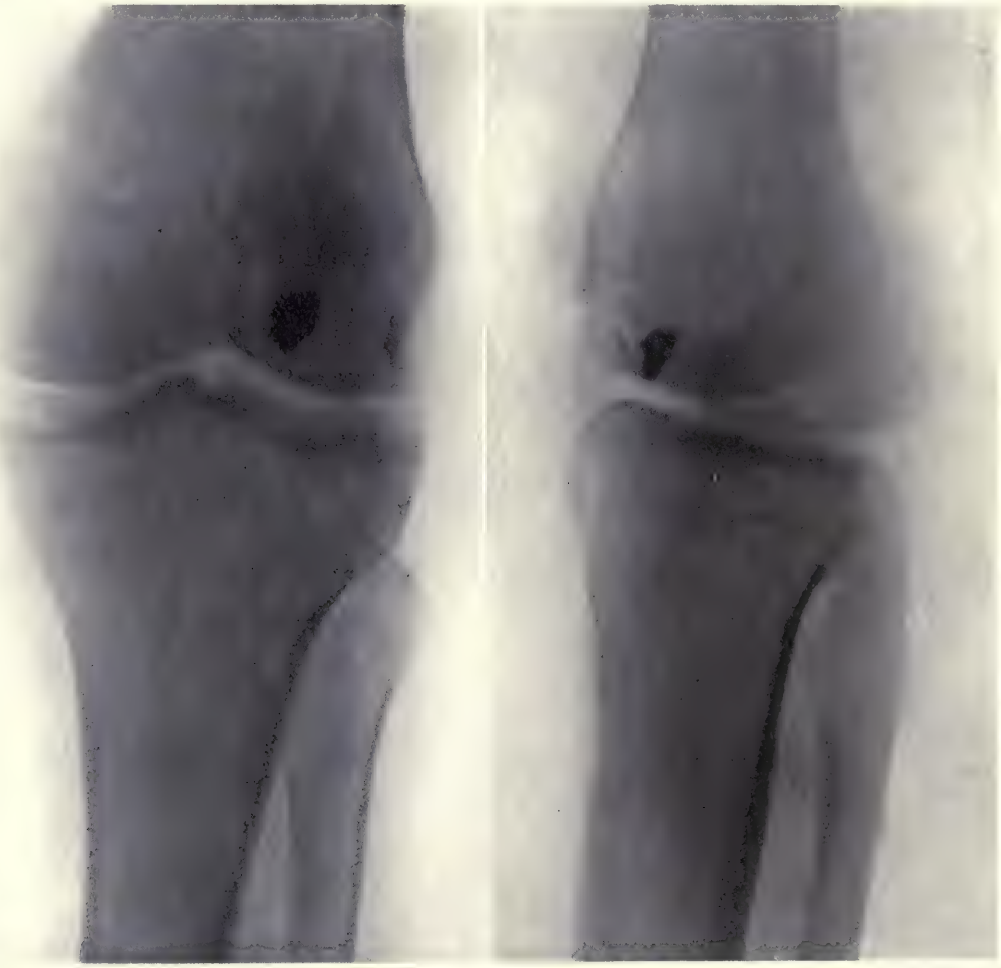
Plate 39.

Radiologist and surgeon must work hand in hand for the benefit of the patient. The radiologist who never attends an operation cannot possibly understand the problems of the surgeon nor learn how best to assist that particular surgeon. Every surgeon has different methods, and it is well that the radiologist attached to a military hospital should endeavour to assist the surgeons of that hospital. So also the surgeon must, for the best results, understand the methods and the limitations of the radiologist's sphere. A first principle in all localisation is to place the patient in the operation position. The second equally important point is to make certain that the surgeon thoroughly understands (1) the position assumed by the patient during the localisation and photographs ; (2) that a line drawn vertically downwards from the skin mark to the table passes through the foreign body ; (3) that the slightest variation during the operation in the position of the patient will ensure that the line does NOT pass through the foreign body. For the sake of the patient the radiologist should at first endeavour to have the surgeon present at the X-ray localisation to decide the position of operation. After some practice the radiologist gets to know the position the surgeon will prefer for the various sites in which projectiles lie.

Small objects, or objects which are indistinct in very thick parts of the body, are rendered more visible and clear by using a small screen, about four inches square, with a reduced diaphragm. The diminished area of fluorescence thus obtainable acts more efficaciously than the smallest diaphragm opening with a large screen. Dr. Thurstan Holland has invented a small screen for use with the Hampson method of localisation which takes advantage of this fact.

At first our installation did not include a stereoscope, and all localisations were carried out by the Hampson method. In the case of a leg or arm it is, however, of comparatively little value to be informed that an object lies at a depth of so many centimetres from the surface when the limb lies in a given position. Even if that figure is corroborated by a second localisation taken from the opposite side, the anatomical information required by the surgeon for operation is lacking in such a method of "accuracy." Two photographs taken at right angles supply more useful information, as they tell the relationship of the foreign body to the bones. Best of all, in such cases—for occasionally photographs may not turn out successfully—best of all methods is to examine the limb in the presence of the surgeon, turning it in all directions, so that the exact position in regard to the bone may be seen and the movement watched while the various muscles are put into play. When a large number of foreign bodies are present in a limb it is best to rapidly mark them with a skin pencil, and then give the surgeon two photographs taken at right angles. It is useless and also dangerous both to patient and operator to attempt to localise them all by the Hampson method.

The scapular region was a not infrequent position for foreign bodies which could not be left *in situ*. Naturally, the surgeon must know whether the projectile lies anterior or posterior to the scapula before deciding whether to enter from the back or the axilla. Even when we possessed a stereoscope we found it sometimes difficult to decide on which aspect of the bone the object lay. In some cases the double photograph on one plate solved the problem—the displacement of the two images deciding which was further from the skin. After seeing the difficulties the surgeon had to contend with, I decided to localise and mark the skin with the patient in the operation position. For foreign bodies in the scapular region the surgeon preferred, I found, to have the patient lying on the side opposite to that in which the object was present, with the affected shoulder supported so that it was raised from the couch. Thus the patient lay in a semi-reclining attitude, in which it was a comparatively simple matter to screen the shoulder region. The foreign body was localised with the man thus propped up, and to ensure that he should remain in that position during operation the vertical measurement from couch to skin mark was carefully noted. As the mark so frequently gets out of place after the skin incision has been made, a second measurement was usually taken from couch to acromion process. By this method we obtained the nearest possible



Case 4.

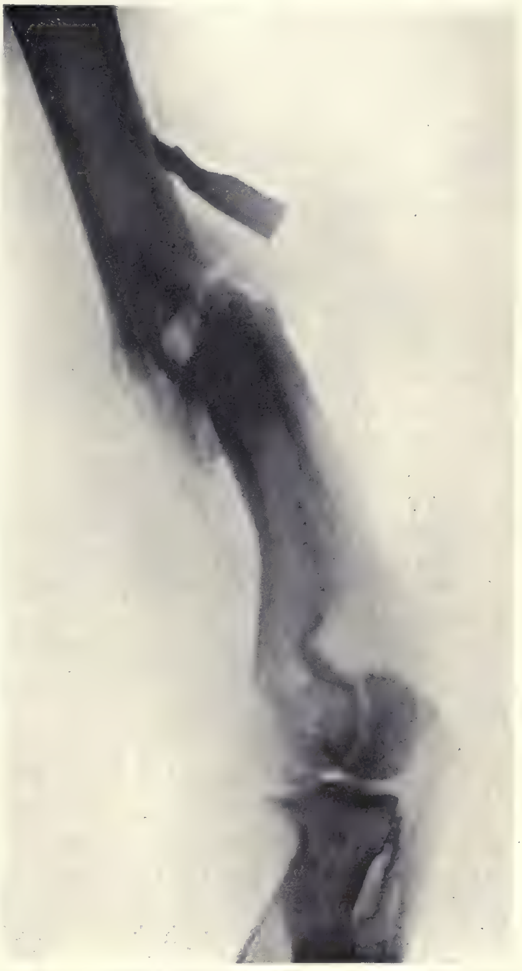
Anterior Aspect.

Lateral Aspect.

approach to the right angle method, which is unfortunately unattainable from side to side through the chest. The surgeon could place the patient in the precise position to a centimetre in which the localisation had been made, and know that a line passing obliquely through the shoulder would traverse the projectile. With a powerful installation a photograph could be taken in that position—we never succeeded in obtaining one of any value.

The ready effaceability of the *marks* placed on the skin was another problem with which we experienced much trouble. Iodine, aniline pencil, ink and silver nitrate markings were all tried in turn; and also two other methods described by other workers as satisfactory, the details of which I have now forgotten. All were liable to magical disappearances; but silver nitrate and thermocautery marks were employed as the most indelible when there was any probability that the case might not be brought to the theatre for some time.

Latterly we began to employ Behiern's compass for localising foreign bodies in the limbs, and were satisfied with its usefulness when the operation took place shortly after the localisation. It is a very simple method, but involves even more screening than the Hampson method. The Hirtz compass was the method most favoured by French surgeons, and the accounts I received of it from French radiologists and surgeons have decided me to master its somewhat alarming preliminary calculations and drawings.



Case 5.—Bullet Wound of Upper Arm with Fracture of Humerus. Bullet remained in Corico-Brachialis when fracture was set, but subsequently removed.

Cases describing the accompanying skiagrams :—

Case 1.—L.G., admitted at the end of September, 1915, with a septic wound of the upper lip and cheek, fracture of the left lower jaw and right superior maxilla, due to the bursting of a shell. There was a large tender swelling beneath the left jaw, which rapidly decreased, until by mid October it had entirely subsided. A skiagram showed that there was a foreign body in the left side of the neck, near the vertebræ, but as there was no pain or physical sign it was decided to leave it alone, and the man was kept in hospital under observation. On November 14th there developed a tender swelling over the left sternomastoid, and two days later this swelling had to be incised. A large abscess was found, with the bit of shell in its centre.

Case 2.—B.L., wounded at the back of the knee by a hand grenade on the 16th of Septem-

ber. The wounds were apparently quite superficial, but on the 21st the foreign body—a nail—had to be removed from the neighbourhood of the popliteal artery. The pus around it contained staphylococcus and the bacillus perfringens.

The two following are examples of apparently quiescent cases, requiring operation after a prolonged period of time :—

CASE 3.—M—. Shrapnel bullet wound on August 30th, 1914, piercing the scapula from behind. He remained in a French hospital till the end of October, when his wound had completely healed. On his return to the trenches the following summer he suffered so much from pain in the shoulder on exertion that he was sent to Royaumont in November, 1915. He complained of dull aching in the shoulder, and movement upward and backward was found to be limited. X-ray examination localised a shrapnel bullet 9 cm. from the front and 6 cm. from the back. On November 23rd an incision was made along the outer border of the pectoralis major and the axilla was explored with the finger. A movable encapsuled object was felt high up, below the axillary contents. The fascia was opened again at a lower level, over the subscapularis, and the bullet was found between the subscapularis and the serratus magnus, at the level of the inner border of the scapula. The wound healed by first intention.

CASE 4.—M—n, received a penetrating shell wound of the left knee on October 22nd, 1914. He was sent to Royaumont, as his walking was greatly impeded by the stiffness of his knee joint. He had been told at several hospitals that he had a foreign body in the knee joint, and that it was in too dangerous a situation to permit of operation for its removal. X-ray photographs revealed a piece of shell in the external condyle of the femur. On November 22nd a horseshoe incision was made through the skin as far as the lower edge of the patella, and the skin flap reflected as far as the middle of the patella. Under the old healed wound scar was found an encapsuled piece of cloth, in which the bacteriologist found streptococci. The knee joint was opened on each side by two vertical incisions, and the patella sawn through. Adhesions between articular surfaces of femur, tibia, and under surface of patella; discolouration at the articular surface of the external condyle of the femur followed up and two small pieces of fractured bone discovered, and a small piece of shell embedded in a cavity in the bone. The patella was wired horizontally with silver wire, and two gauze drains inserted at the sides of the wound. The wound healed by first intention, and passive movement was begun at the end of a week.

CASE 5 illustrates the well-known fact that rifle bullets usually cause clean wounds.

G——, æt. 32, was wounded in January, 1915, by a bullet, which entered the left arm below the posterior border of the axilla. He lay in a trench between the firing lines for four days, without food, drinking rain-water as his only sustenance. Both hands and feet in consequence were frost-bitten. Treatment by galvanism improved the frozen members, so that by May sensation was normal, but owing to the atrophy of the leg muscles his walking powers remained limited. An X-ray photograph showed a bullet lying apparently embedded in callus. At an operation, performed at the patient's request, in May, it was found in the corico-brachialis muscle, quite detached from bone.

All the operations described above were performedby Dr. Frances Ivens, of Liverpool, who is still acting as Médicin-Chef and chief surgeon at Royaumont.

THE CLINICAL SIGNIFICANCE OF RADIOGRAPHS OF THE ORBITAL REGION.

By Dr. H. W. Stenvers,

House Physician at the Psycho-Neurological Institute (Professor Winckler), Utrecht, Holland.

In X-ray examinations of the skull both sagittal and lateral or frontal reproductions are generally made; both are indispensable for examination purposes. When, however, it is desired to obtain a specially accurate negative of some particular region of the skull, radiographs taken in other directions are frequently essential.

Such a procedure is objected to by many on the grounds that the radiograph presents an uncertain and indefinite tangle of lines, and is consequently useless for diagnostic purposes; nevertheless, I wish to show, with the aid of a few examples, that this is by no means the case. Each particular position of the skull causes particular lines to come to light, and the fact of their constant recurrence indicates that they are not artefacts but the representations of definite anatomical features. Their correct explanation can, however, only be determined by means of experiment. In the present paper I shall confine myself principally to the discussion of the *Foramen opticum* and the *Fissura orbitalis superior.*

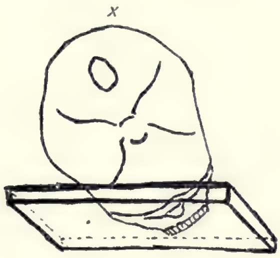


Fig. 1.

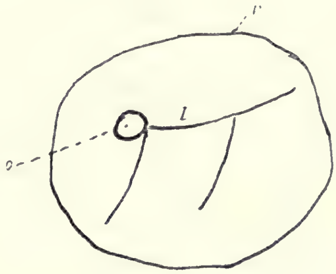


Fig. 2.

In the *Archiv. für Laryngologie* (Bd. 24, Heft. 3), Rhese describes the method of application of the plate to the skull in studying deformities of the ethmoid. "The plate is so adjusted to the face that one edge rests upon the zygoma of the side under examination and the other upon the ridge of the nose."

According to Rhese a few lines upon the negative so obtained are specially to be considered, as shown in Fig. 2; "r" indicates the edge of the orbit, "o" is the optic foramen, while the line "l" marks the junction of the lamina papyracea of the ethmoid and the frontal bone.

Working with skulls, my experience does not agree with the explanation given by Rhese. By placing a metal pin on the line of junction of the lamina papyracea and the frontal bone, and then taking a skiagram, as described above, the metal pin is shown to project above the thick line which Rhese calls "l." Obviously, then, the line indicated by "l" lies lower, and does not in point of fact coincide with the suture between the ethmoid and frontal bones. By covering the crista galli and the cribriform plate of the ethmoid with lead-foil (as shown in Fig. 3a), a dark projection is seen in the radiograph which corresponds absolutely with the line "l."

This proves, as is evident by comparing Fig. 3 with Fig. 3a, that the line "l" is not the suture between the ethmoid and frontal bones, but is produced by the cribriform plate of the ethmoid. I have indicated this line on my sketches as the skull base line.

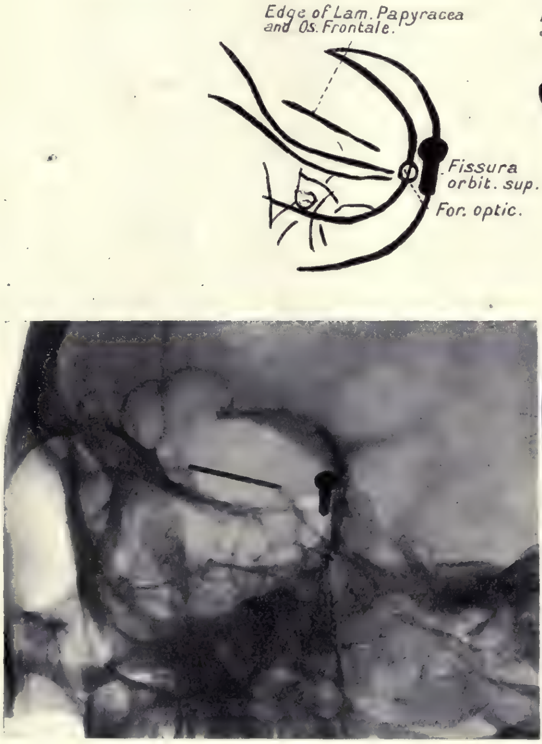


FIG. 3.

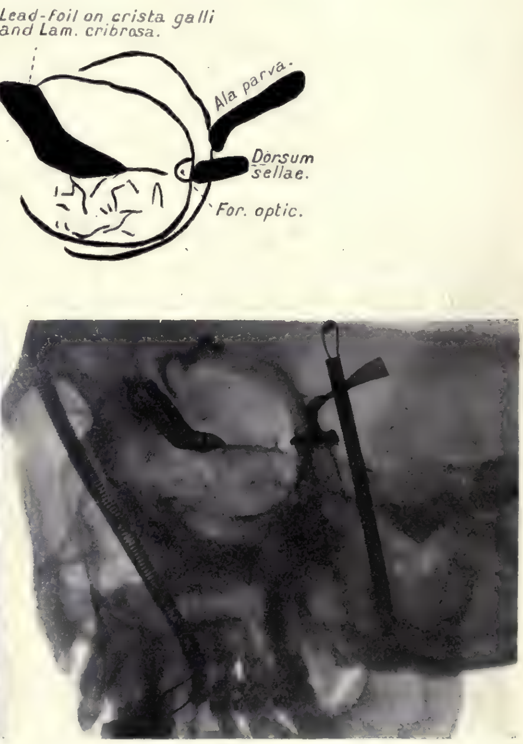
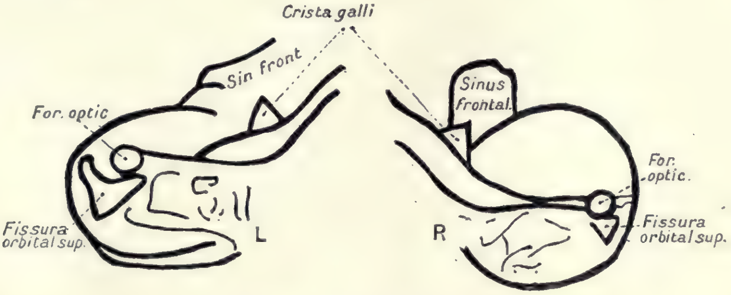


FIG. 3A.

The fissura orbitalis superior is indicated in Fig. 3 as a screw-shaped figure, which is situated beyond the sphere of the orbit. By placing the nose-chin line a little closer to the plate, however, it will easily be found within this region. To what extent this will occur cannot be stated by mentioning any specific angle, for the length of the nose and the shape of the skull determine its relative position for each separate case. In one instance the nose will have to be closely approximated to the plate, while in another a less degree of approximation will suffice. Moreover, the angle formed by the sagittal axis of the skull and the base will vary within certain narrow limits. Simultaneously with the fissura orbitalis superior, the foramen opticum returns within the circumference of the orbit. In the next X-ray photos, which were all taken in the manner described above, the results are evidently satisfactory.

In *Die Schädelbasis im Röntgen Bilde*, by Schüller (p. 929), we find a method for the reproduction of the foramen opticum and the fissura orbitalis which, in my opinion, is too dogmatic, inasmuch as the variety in length of noses and in the shape of the skull renders it impossible to indicate any definite angle, as advised by Schüller.



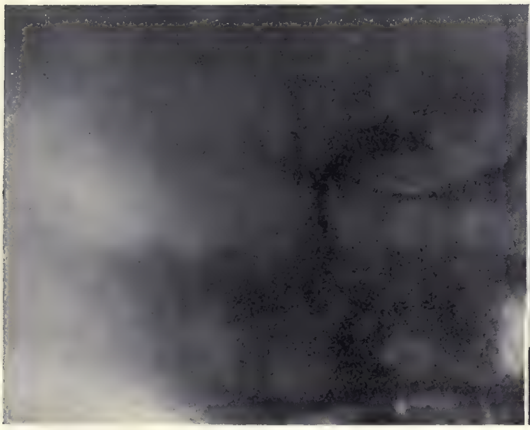


FIG. 4.

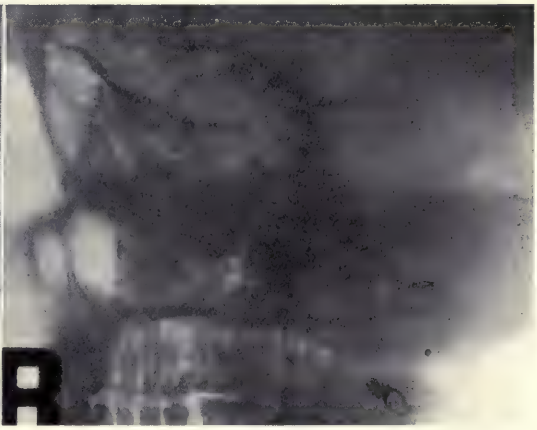


FIG. 4A.

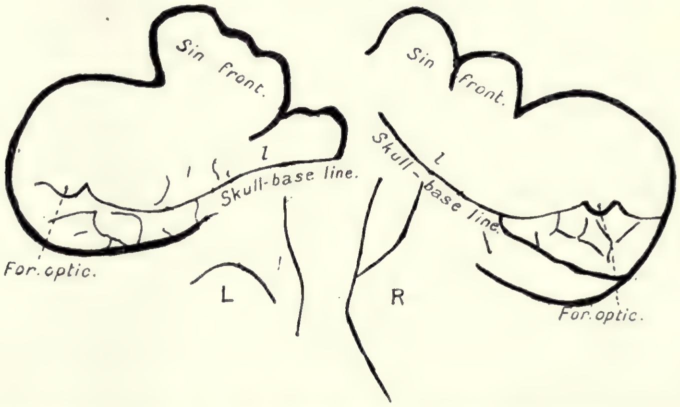
Each skull will require a particular procedure in order to be photographed. The objection made against this assertion, namely, that in this case photos of various skulls will not allow an ideal comparison, is of course valid. However, I consider this to be of very slight importance, taking into consideration the vast difference in orbitas of various people, whereas comparison of the orbits of various people is of but little clinical significance.

The only comparative object for an orbit is the other orbit of the same individual. The above objection is more than counterbalanced by the advantage that, adapting one's self to the circumstances, more successful reproductions of the foramen opticum and fissura orbitalis are obtained.

The radiograph of an orbit is only then of significance when—as also stated by Rhese—the other orbit of the same individual is taken in an exactly similar manner.

In order to demonstrate the practical worth of these pictures for the observation of pathological formations in and around the orbit, I shall endeavour to describe a few instances recently met with :—

(I) The first observation concerns a patient who had suffered for some years from lymphosarcoma on the left side of the throat. She was operated upon one and a half years ago, which necessitated the left nervus vagus, n. accessorius and n. hypoglossus being severed. Three months after the operation she started to see "double," a condition which became worse and worse, while the left upper eye-lid showed gradually increasing ptosis.



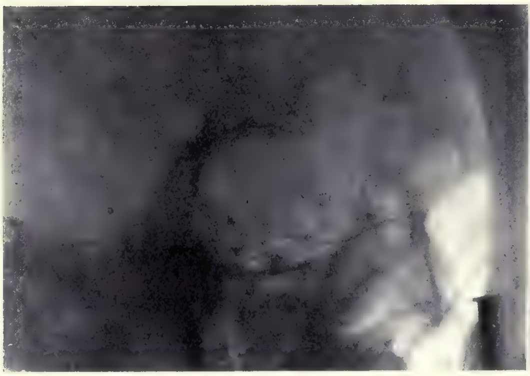


Fig. 5.

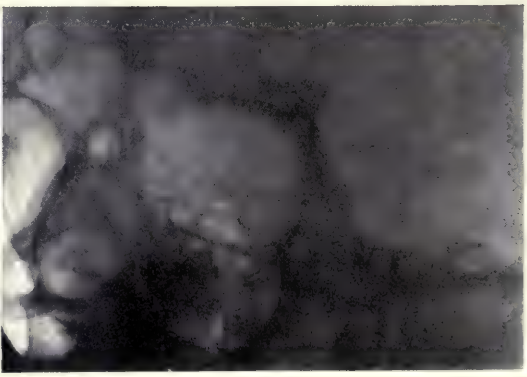


Fig. 5a.

At present the left eye cannot be moved at all, while the power of vision is considerably diminished. The parts supplied by the first and second branches of the left trigeminal nerve are anæsthetic. Moreover, the patient suffers from strong trigeminal neuralgia on the left side.

The clinical diagnosis is stated as "tumor orbitalis," destroying the delicate parts around the eyeball in the orbit.

The radiograph confirms this diagnosis, as is shown by Figs. 4 and 4a.

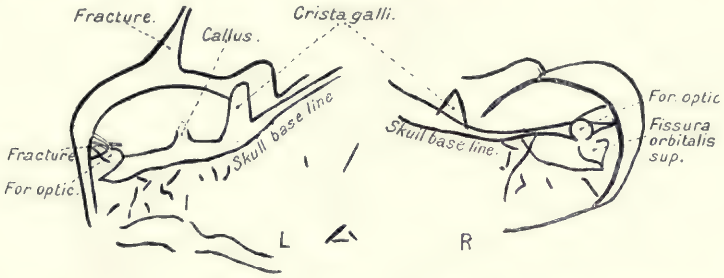
The fissura orbitalis of the left side is obviously larger and wider than the one on the right side.

The connection of foramen opticum with the skull base, which is plainly seen on the right side, is considerably thinner on the left side. Moreover, the entire sphere of the orbit on the radiograph is hazier on the left than on the right side.

(II) The second instance is that of patient R., a man fully 40 years old, who became blind in almost six or seven weeks.

Neurologically, an atrophying papillitis was found on both sides. Pupil reaction to light gone on the left side, normal on the right. Visus: on the left side, only light was observed; on the right side $\frac{5}{30}$.

Besides a few limitations in the eye movements and undefined footsole reflex, no further points were made in the diagnosis. Only by rhinoscopy anterior and posterior, somewhat enlarged conchæ were found. Smell: very insufficient on both sides. Clinically, no accurate diagnosis could be made without the aid of radiography. The preliminary sagittate, and lateral or frontal radiographs did not furnish the desired information. On the first radiograph the alæ parvæ and the whole os ethmoidalis appeared very indistinct, while the sinus sphenoidalis had a markedly narrow lumen.



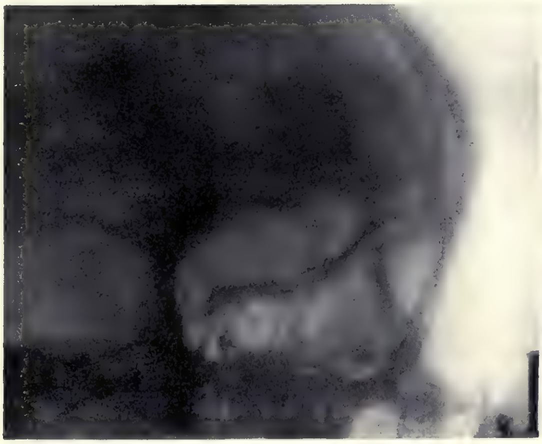


FIG. 6.

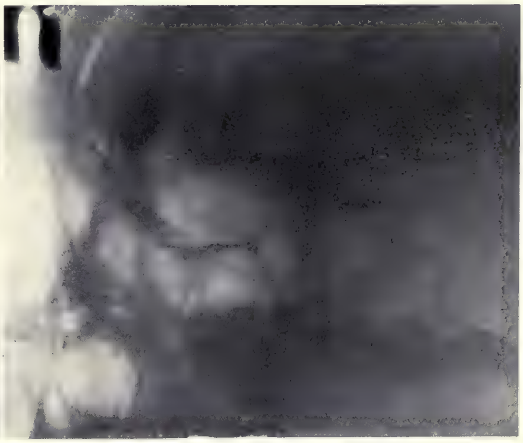


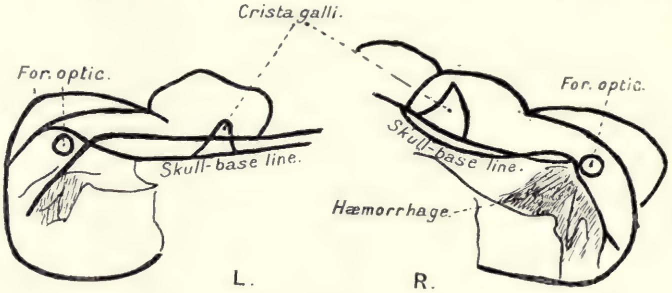
FIG. 6A.

Now, examining the two radiographs taken through the orbits (Figs. 5 and 5a), it appears that the entire skull base line has disappeared, as has also the upper edge of the foramen opticum, on both sides.

Judging from the radiographs, we must come to the conclusion that there is a tumour of the base of the skull situated quite anteriorly. The tumour absorbs the crista galli and lamina cribrosa (*vide* thin line "1"), and partly destroys the ethmoid. It continues along the os sphenoidale. The development of similar tumours, even in a rather advanced state, without more distinct local manifestations, is sufficiently well known clinically.

(III) The third instance is that of a patient called L., a man who, after a fracture of the skull, gradually became blind. The exact clinical description of this case is given by Dr. de Kleyn in Graefe's *Archiv für Ophthalmologie*, Bd. 82, page 155.

Let us, first of all, examine the radiograph of the uninjured side (Fig. 6a). We notice the crista galli and the skull base line. The foramen opticum is to be limited by a sharply curving line, which is not entirely closed on the lower portion. Above the foramen opticum we notice a dark mass, which continues along the skull base line.



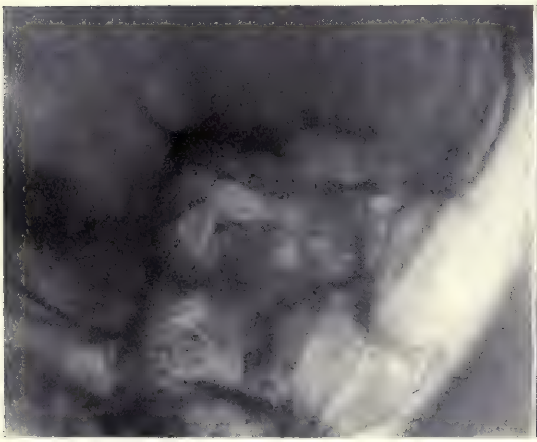


FIG. 7.

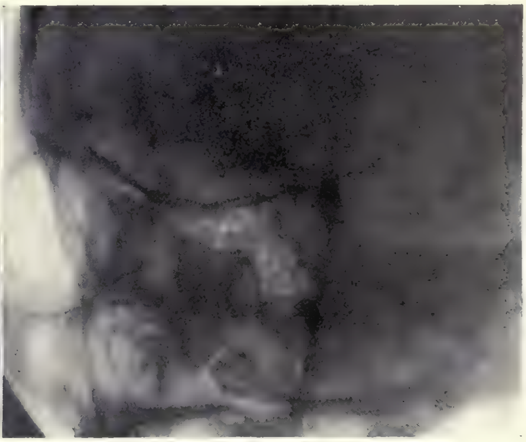


FIG. 7A.

Examining the injured left side (Fig. 6) we also see the crista galli. Continuing along the skull base line we notice again an elevation, resembling a second crista. Thereafter the skull base line thickens and runs through a lighter portion of the radiograph underneath the foramen opticum.

The radiograph of the right side shows the fissura orbitalis, the edge being not entirely continuous. There is (in Fig. 6) an interruption in the upper side, and from that point starts a diminutive fracture line; the back part is sharply curved in contrast with the front part, the back part being also thickened.

Judging from the radiographs we must come to a diagnosis of a fracture of the skull base, which is situated in the foremost skull groove, penetrating the foramen opticum.

(IV) Finally, I will describe the fourth instance, a male patient who, in consequence of a bayonet thrust in the right orbit, suffered from a total paralysis of all eye muscles on the right side, and ptosis of the right upper eye lid. As far as the eye movements were concerned, the clinical picture was identical with the case first mentioned.

Comparing the radiographs of both the orbitæ we notice a rather sharply outlined blot in the fissura orbitalis of the damaged side. In view of the known injury, this blot cannot be but a hæmorrhage. Considering the limitation and direction of this blot, it is probably located within the hollow made by the converging eye muscles.

Resuming, I come to the following conclusions :—

(I) Rhese's method is, besides being important for the ethmoid, still more significant for the orbit.

(II) The line "1" indicates the lamina cribrosa.

(III) In taking radiographs the individual construction of the skull should be taken into consideration.

(IV) Radiographs are of great importance for clinical diagnosis, in some cases indispensable.

(V) Hæmorrhages in the orbit can be reproduced by means of X rays.

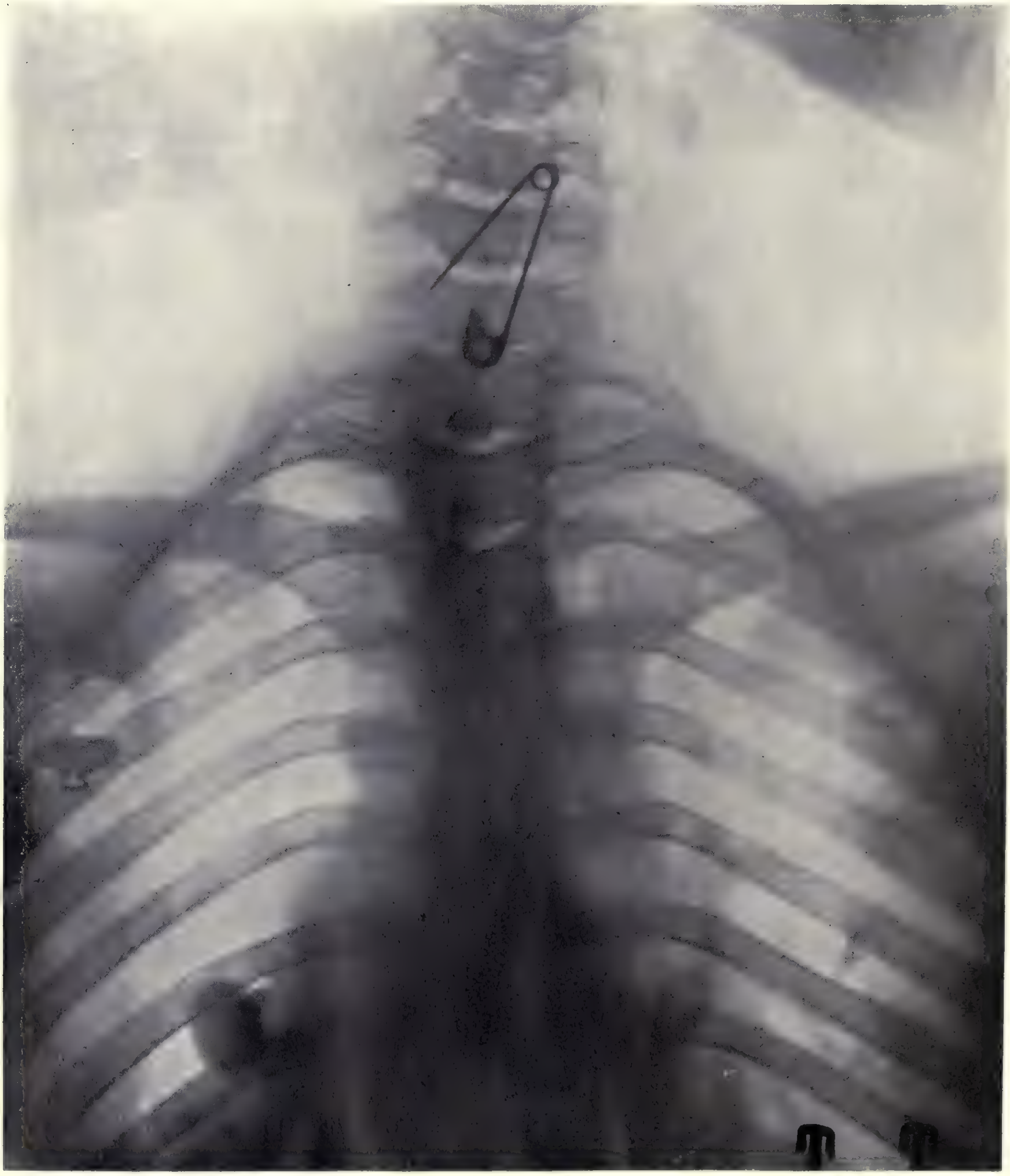
(VI) Dimness in the picture of the os ethmoidale does not always indicate an injury of the os ethmoidale.

CASE OF PIN IN ŒSOPHAGUS OF PATIENT WITH UNSUSPECTED BI-LATERAL CERVICAL RIBS.

By Dr. F. Emrys-Jones, Birmingham.

The above case seems to be rather a unique one, as the double cervical rib was only detected on taking a plate. I saw the patient a few hours after the pin had been swallowed. She had very little pain, but could not swallow solids. It was seen on the screen that the pin was open. An operation was performed at the General Hospital by Percival Mills, F.R.C.S., the following morning, a short account of which he has kindly sent me, and which I herewith enclose.

Operation for removal of safety-pin.—Under general anæsthesia an œsophagoscope was easily passed and the safety-pin was seen lying in the œsophagus with the angle upwards. Several attempts to grasp it with the special forceps made for the purpose failed, as the shaft of the forceps always obstructed the view of the object to be grasped. Further efforts were prevented by a failure of the electric light. An incision was made along the anterior border of the sterno-mastoid on the left side. This muscle, with the great vessels beneath it, was retracted outwards, while the trachea covered by the sterno-hyoid and sterno-thyroid muscles were drawn inwards. The safety-pin was easily felt in the œsophagus and removed through a longitudinal half-inch incision, which was then sutured with catgut. The wound was then closed, a small drainage tube being passed down to the sutured œsophagus and left in position for thirty-six hours, when it was removed permanently. The patient had fluids by the mouth the day after the operation and soft food only for the first week. The wound healed by first intention, and she left hospital to return to her work on the tenth day.



Radiograph showing safety-pin in œsophagus of patient with unsuspected bi-lateral cervical ribs.
By Dr. F. Emrys-Jones, Birmingham.

THE TREATMENT OF THE SCARS OF WAR.

By Noel H. M. Burke, M.R.C.S., L.R.C.P.
Medical Officer in charge of Electrical Department, County of London War Hospital, Epsom.

A short while ago there was some discussion in one of the journals on the treatment of fibrous adhesions causing disability after wounds of war, and it is possible that the two following cases may be of interest, as they show rather conclusively how much can be done by electrical methods.

Case 1. Sergt.——, R. Inniskilling Fusiliers, had a shrapnel bullet through the left forearm at Suvla on August 21st, 1915, with a comminuted fracture of the radius. He was sent to me for weakness and pain on October 4th, the fracture being then united in good position, and the wounds healed. The scar of entry was on the middle of the back of the forearm, 2 inches from the wrist joint; that of exit was 2 inches higher on the front of the forearm, shaped somewhat like a grenadier's badge, and 1½ inches by 1 inch in size. The weakness of the hand was found to be due to limitation of muscular movements by the dense scarring, particularly on the anterior aspect. Voluntary power of all muscles was present, but very weak; electrical response was weak, but of normal type.

Treatment was:—20 minutes heating by an electric light bath, followed by ionisation with chlorine at and around the anterior scar for half an hour. This was carried out three times weekly, and massage and movements were done daily at a later hour.

On December 30th a note was received from the Medical Officer in charge of the patient's ward, asking that he should have a rest from the treatments, as the masseuse found the hand stiff and painful after them. This was very surprising, but was explained by the answers to a few careful questions, when it was found that it was on the day *following* the treatment that massage was painful, while on the actual day of treatment massage was more comfortable to the patient, and more movement was obtained.

On January 24th, after 42 treatments, the grip was good, and pain only felt at the beginning of massage, and more so on the days when the scar had not been previously softened electrically. Five treatments a week were now given instead of three, and a final examination made on February 28th after 17 further séances. The anterior scar was very much softer, the skin being quite supple over it and free, except in one small point where it was still pulled upon by the action of the flexors, but without in the least interfering with their full range of movement, and without causing pain. The hand had now a good strong grip, and the man was quite fit to return to full duty.

Case 2. Pte. ——, A.I.F., had a bullet through the left hand at Anzac on August 9th, 1915. His only treatment since September 15th had been massage, and the wound had been healed for three weeks. He was sent up to a Medical Board for discharge, but referred by it to me for treatment.

When seen on November 24th the hand and fingers were stiff, wasted, and showed only a very little movement. There appeared to be a great deal of matting together of all the tissues, but each muscle on Faradic stimulation gave its action very weakly on the appropriate finger, thus showing that the tendons were fairly free, and in continuity. Treatment was the same as for Case 1, except that a bath of salt solution was used for the hand instead of lint.

On January 4th, 1916, after 14 treatments, there was slightly better movement, but of this the patient was very doubtful. Careful measurement was therefore made of the range of each voluntary movement. It was noticed that electrically provoked movements had now nearly double the extent of his own mentally provoked efforts. It was evident that his supply of central nervous energy was very poor, and that he was too apathetic to in any way assist his cure by his own attempts at exercise. This fact was amply confirmed by his own Medical

Officer. He was now given 6 treatments a week—before massage—and on February 12th, after 20 more séances, he was further examined before returning home to complete his recovery.

The entry in the notes on this day was, "Needs much mental stimulation—can then grip a little with all fingers."

The measurements on this occasion compare as follows with those made 5 weeks earlier:—

	4th January.	*12th February.*
Flexion and extension of index, at tip	1¾ inches	2½ inches.
,, ,, ,, ,, 2nd finger, at tip	1¾ ,,	2½ ,,
,, ,, ,, ,, 3rd ,, ,,	¼ ,,	slightly over ½ ,,
,, ,, ,, ,, 4th ,, ,,	⅛ ,,	,, ,, ¼ ,,
Combined abduction and adduction of thumb, at tip	2¼ ,,	2½ ,,
,, extension and opposition ,, ,,	4 ,,	4¼ ,,
Flexion of wrist from table, at base of index finger	1¼ ,,	3¾ ,,
Extension ,, ,, ,, little ,,	¼ ,,	½ ,,
Total lateral flexion of wrist ,, index ,,	¼ ,,	2 ,,

Case 1 is interesting because it shows that the electrical treatment definitely produced softening of the adhesions for a few hours, and thus enabled good work to be done by massage, which unaided was of very little benefit. I was so impressed by the unconscious testimony of the masseuse, that all similar cases are now given chlorine ions, after a preliminary heating up by radiant heat, and are then sent for massage to be carried out on the tissues so prepared.

A second consideration is that though slow (Case 1 was treated for 5 months, and Case 2 was unfinished at 2½ months), there is a good deal of sureness in the electrical method. Patients can, by proper treatment, be returned either to the firing line or to useful civilian life, who are at present too frequently discharged untreated, and with a consequent permanent disability, which makes them a burden to themselves and the tax payer.

The two cases under consideration show this well. Case 1 was able to rejoin his regiment. Case 2 had been nearly discharged untreated. He may now recover sufficiently to do military duty, and will at least be able to carry on his civil occupation without undue difficulty.

REPORT OF SOCIETY.

ACADEMY OF MEDICINE OF CINCINNATI.

Meeting of November 29th, 1915.

End Results of X-ray Treatment of a Tumour Mistaken for Fibroid.

Dr. J. Edw. Pirrung: Mrs. B., aged thirty-five, married, is the mother of one child, now six years of age. Her menstruation, which occurred first at the age of thirteen, has been regular and of normal duration, until about one and one-half years ago, when the period was accompanied with more pain, which became more prolonged and of greater severity with each recurring period, the flow finally extending over a period of fourteen days. About this time, a year ago, a tumour was discovered which caused great pain and discomfort, and seemed to grow larger as time went on. She consulted a physician, who suggested that she try X rays. During the summer she accordingly consulted the roentgenologist, who, after having given her several treatments, sent her to a gynecologist for conformation of diagnosis. They were agreed that it was fibroid. During all this time there had been no reduction in the size of the tumour or in the amount of bleeding. Four or five years ago I had operated upon this lady for hæmorrhoids. A pelvic examination at that time failed to reveal the presence of anything abnormal either in the uterus or in the adnexa. On November 20th she was seized with pain in the right side, which was constant and of a continuous tearing nature. I was called in to see her on Sunday, the 21st, when she informed me of the tumour, of the various treatments, etc. I suspected that she had had a recent X-ray treatment, which might account for her indisposition and sick stomach. However, she told me that she had had no treatments during the past two weeks. Examination at that time led me to believe that it was pressure from the tumour which was responsible. I ordered rest in bed and advised the removal of the tumour. The patient was removed to the hospital, and on November 23rd was anæsthetised for operation. External examination at that time revealed a freely movable tumour attached to the lower abdominal or pelvic organs. I diagnosed it to be either cyst or the ovarian tumour. These specimens were removed. The right ovarian pedicle was found to be partially twisted, thus accounting for the pain she had suffered on Sunday previous to the operation. The operation was fully completed at the end of twelve minutes.

I do not suggest that all fibroids should be operated upon, but I do maintain that until we know more about tumours, we had better adhere to those methods which have proven valuable, rather than to trust the newer methods of which we as yet know so little. X rays will aid in the control of bleeding by its direct effects upon the ovarian tissue, shrinking it or completely destroying its function. That the X-ray can reduce the size of a tumour, we have no positive evidence, since measurements are fallacious if taken during the menstrual life, for the reason that the uterus is always in a state of congestion or œdema in the presence of a fibroid or other tumour, than to have a physiologic flow of blood in and out of the uterus. Some of the causes and effects of tumour are mechanical; others, such as degenerations, infections, pressure effects, as pressure upon the ureter, causing hydronephrosis or infection of the kidneys, the bladder, irritation causing aptates, or intestinal obstruction, by pressure of the tumour or adhesions formed with other organs. Cystic, hæmorrhagic, calcareous and other degenerations occur, to say nothing of the possibilities of a tumour located in such a manner that chronic irritation of the lining of uterus might cause cancer to occur. That sarcoma cannot be diagnosed from rapidly-growing fibro-myomatous tumours we are all agreed.

With these facts before us, we should hesitate very seriously before sending our fibroid cases requiring treatment to the radiologist. Those cases demanding treatment for the relief of pressure symptoms, bleeding and degenerations, all other things being equal, had better submit to the surgery of proven value than the X-ray, which is as yet unproven. Above all else in importance, is the necessity for surgical exploration in determining an abdominal diagnosis, because of its uncertainty.

Dr. B. M. **Ricketts**: These perineal masses vary so in character that it is impossible for any man to obtain sufficiently accurate knowledge to differentiate them. They cannot be determined by the sense of touch. The introduction of needles will not determine them. The mass may be semi-solid, or it may contain the dermoid matter, as we had here the other evening. It may be fibroid or not fibroid, and simply complicated. It may be connected with the uterus, may be an ovary, retro-peritoneal or a cyst. For this reason I have condemned the application of the X-ray to the abdominal wall for fibroid tumours. If the X-ray should be proven efficient for fibroid tumours, the abdomen should be first opened and the character of the growth determined. Even then we ofttimes find a large mass of calcareous matter. Therefore, I believe it is better to open the abdomen and learn the character of the tumour; then, if advisable, apply the X-ray.

Dr. E. C. **Steinharter**: There is no doubt that we must know with what we are dealing before subjecting a patient to the X-ray treatment for a presumed fibroid of the uterus. Such a tumour may turn out to be a sarcoma, or a carcinoma, or a fibroma undergoing malignant degeneration, and even after the most careful examination of the case one may be able to arrive at a diagnosis of the type of neoplasm before operation. As an example, I may cite a recent case in the wards at the general hospital. In this particular case a careful study of the history of the patient and a careful physical examination led to the diagnosis of a simple fibroid of the uterus, but at the operation, performed by Dr. Withrow, the tumour revealed itself as a rapidly growing sarcoma. A curettage and a study of the uterine scrapings for the purpose of diagnosis in any instance may or may not be of profit, depending upon the particular location of the growth.

In regard to uterine hæmorrhage not complicated by a palpable tumour, here, too, before the case can be intelligently treated, one must arrive at the diagnosis of the cause of the bleeding. It must be remembered that the hæmorrhage may be due to many different causes, few of the chief ones being (besides malignancy) polys, hypertrophic endometritis, displacements adnexitis ovarian neoplasm, certain constitutional diseases and the treatment of the hæmorrhage by the production of an artificial menopause, may be indicated only in the exceptional case. So while I feel that roentgen therapy has its place in gynecology its use should be reserved for the carefully selected case which, for some reason (other than that of the fear of the knife) should not be treated according to the usual methods.

Dr. Walter R. **Griess**: I think this is a very instructive case. All men doing surgery have seen women between the ages of forty-five and fifty years afflicted with fibroid tumours who are poor surgical risks, on account of a grave secondary anæmia; and all men of any experience have lost such cases simply from the shock that was endured at the time of the operation, and which the patients in their anæmic condition could not tolerate. If we really want to do our full duty to wards our patients we must always play safety first.

Dr. Sidney **Lange**: I think the viewpoint brought out in the discussion is rather extensive. I do not think that treatment with the X ray has been advanced as a substitute for surgery. The criticism made is a very just one, however. I do not know just what the tumour is in this particular case. It may have been a case that I have treated or it may not. The cases which I have had have been for the most part fair surgical risks, but have for some reason absolutely refused operation.

The X ray ought not to stand as a substitute for surgery. With regard to the value of the method used, there is literature now dating back to 1904, which speaks very well for the after-results of the method. As to the welfare of the patients, I do not think you can often expect much in the way of results in cases where the diagnosis is wrong, and where the condition turns out to be a slow-growing carcinoma. There are numerous cases of this kind on record.

Dr. Chas. **Goosmann**: I have never, so far as I can recall, defined the use of the X ray as a sort of an easy anæsthetic knife. I do not believe that the X ray will remove large fibroid tumour, but these anæmic cases to which reference has been made do seem to improve under X-ray treatment to such an extent that they can, perhaps, afterwards endure surgical operation. But after they improve, they naturally refuse to be operated upon, so the thing becomes an endless chain. There is no question but that the surgeon is necessary in these cases. Results can be obtained by means of surgery with a less expenditure of time and possibly money than by the X ray. After all, it finally resolves itself into the old idea of "choosing between two evils."

Dr. J. E. **Pirrung**: I did not advocate surgery for all cases of fibroid tumour, nor did I say that there was a great fatality in those untreated. We have records with a history of 2,000 cases untreated with a mortality of 1 per cent. In the operative cases of less than 2 per cent., considering that infection and degeneration occur, such a mortality of 2 per cent. is exceedingly favourable. Therefore, we should not be unnecessarily alarmed concerning the great mortality, whether we operate or not.

I do not advocate operation for all of these cases. I agreed that the X ray would reduce the amount of bleeding, but I maintain that it cannot reduce the size of the tumour. You do not have that abnormal congestion that exists during the menstrual life.

Dr. **Lange**: Upon what do you base your opinion about the X ray not reducing the size of the tumour?

Dr. **Pirrung**: Upon measurements taken.

Dr. **Lange**: Suppose, after six months of X-ray treatment, the tumour is found to be half its original size?

Dr. **Pirrung**: In that case you have brought about the menopause. You have stopped the normal periodic and physiological flow of blood into the uterus, thus reducing the liquid content of the uterus. In many of these cases we find hypertrophy of the heart disappearing upon removal of the tumour, because its work is thereafter reduced.

NEW TECHNIQUE.

A NEW METHOD OF LOCALISING FOREIGN BODIES BY THE FLUORESCENT SCREEN.

By A. E. Carver, M.A., M.D. Camb.

Physician with charge in Electrical Department to Birmingham and Midland Hospital for Diseases of the Nervous System. Radiologist to "The Birmingham Hospital Unit."

The importance of rapid and easy localisation of foreign bodies has been brought home to radiologists with unusual force since the outbreak of the war, with the result that a considerable number of systems are now in use. These, although varying in detail, are practically all based upon the principles involved in Sir Mackenzie Davidson's method, which consists essentially of reconstructing the path of the rays. Their disadvantage is that several measurements must be accurately made or known and then plotted out diagrammatically. This necessitates great care and accuracy in every stage of the proceeding, with a consequent expenditure of precious time.

All radiologists will, I think, agree that increased rapidity and diminished liability to error remain the great desiderata.

It is for this reason that I venture to put forward the following method, which is extremely simple and rapid when one is dealing with a foreign body easily visible on the fluorescent screen.

The principle underlying the method was independently arrived at by Dr. E. Shenton, of Guy's, but the details of his procedure, which are not yet published, differ from those here described.

The great advantage of the new method is that neither the distance of the screen from the anticathode nor the tube shift need be known. It suffices to mark the position of the image upon the screen in the first position of the tube, then shift the tube any convenient distance and mark the second position of the image. If the screen be now raised until the distance between the first and second image has been doubled, the height to which the screen has to be raised in order to effect this is equal to the distance of the foreign body below the screen. (Fig. 1.)

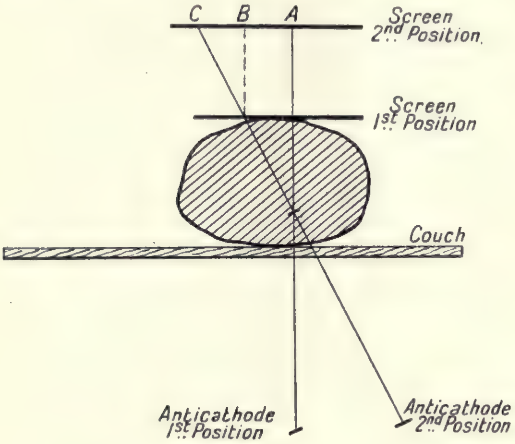


FIG. 1.

The screen is most conveniently attached to an adjustable arm working upon a vertical support (*e.g.*, the tube stand, Fig. 2, or an upright from the tube box).

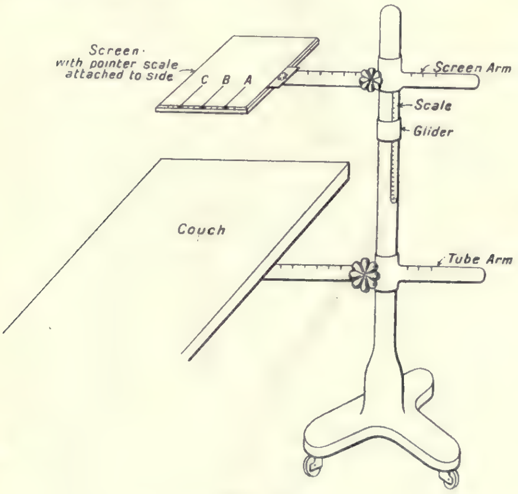


FIG. 2.

A spring glider moves upon this support, and the screen having been adjusted over the patient, the glider is pushed up against the arm, where it registers zero; as the arm is raised it carries the scale with it, and thus when the screen occupies its second, or final, position, the height to which it has been raised is read off at the upper level of the glider.

Thus, the exact depth of the foreign body is arrived at without the need for knowing any other measurement.

The successive positions of the image upon the screen may be given by either of two simple devices.

At first I was in the habit of placing upon the upper surface of the screen a small metal scale with three mouse-shaped weights, A, B, and C, A being fixed and B and C being slipped along until their pointers indicated respectively the second and third position of the image. Latterly, however, I have found it better to work with the scale attached to one side of the screen, and long sliding needles extending across to cut the position of the images.

In practice the manipulations are as follows:— Adjust the screen over the foreign body. Push up the glider (Fig. 2) until it is in contact with the screen arm.

Before proceeding, mark the point of entrance and emergence of the vertical ray for the future guidance of the surgeon.

Then place the little scale upon the screen, with pointer A indicating the position of the image.

Shift the tube any convenient distance and slide pointer [illegible] along scale to indicate the second image

Now raise [illegible] tube until the third image is as far from C [illegible] B is from A. These movements are easily and rapidly carried out, but the pointers on the scale may previously be set. In this case the pointer A is made to coincide with the first image; the tube is racked until the image travels to B, and then the screen is raised until the image moves over to C.

In any case, the height through which the screen has been raised in order to make the distance B C=A B is read off at the upper level of the glider, and gives directly the depth of the foreign body in the tissues, if, in its original position, the screen rested directly upon the patient.

It is, however, not essential that the screen be placed in contact with the patient, but if it were, say one inch away, this distance must be deducted from the reading.

By this method the surgeon is quickly supplied with all essential information as to the exact position of the foreign body, without it being necessary for the radiographer to construct any diagram, or even actually to make any measurement.

This seems to me such a great advance on any method hitherto suggested, that I feel justified in calling attention to it. Practically no special apparatus is required, but any upright connected with the stand or tube box can easily be adapted, and the little scale can be used with any screen. Although primarily intended for localisation by the fluorescent screen, the method obviously is applicable also to photographic work when desired.

NOTES AND ABSTRACTS.

PHOTOGRAPHY.

Chips from a Workshop.—By T. J. Kelly (*Penrose Annual*).—The connection between the photographer and the electrotypist is a close one, though to some extent it has been in abeyance or forgotten. The photographer can obtain plaster casts from the negatives, these also can be electrotyped direct. The process is an excellent medium for producing water-marks, and has a distinct commercial value.

The formula may be new to many readers, and it is as follows:—

First make up the following mixture: Gelatine 4 oz., gum arabic 2 oz., water 20 oz. The gelatine and gum are allowed to soak for an hour; 100 minims of glacial acetic acid is then added and the whole melted by the aid of a water-bath. It will be better if the hot solution is quickly strained through fine linen or muslin. Take a sheet of glass of the size required, thoroughly clean it, and rub well with a waxing solution, made by dissolving 30 gr. of beeswax and 1 dr. of yellow resin in 5 oz. of turpentine. The surplus is polished off, and the glass surrounded with a rim of thick paper, glued to the edges. The plate being placed on a level surface, the hot gelatine mixture is poured in, to a thickness of from $\frac{1}{12}$-in. to $\frac{1}{8}$-in.—the thicker the film the higher the relief, but if too thick there is a difficulty in drying. The plate is dried by the aid of heat, or in an air-tight box containing calcium chloride to absorb the moisture. When dry the gelatine film is sensitized in ammonium bichromate 288 gr., water 20 oz. Sufficient ammonia is added to give just a faint smell. The plate is immersed in this for ten minutes, when the surplus solution is removed gently with blotting-paper, and it is again dried—this time, of course, away from the light. When dry the film will readily strip from the glass. The sensitized film is exposed to sunlight under a negative, the glossy side in contact with the latter. The sun's rays should fall perpendicularly on it, as far as possible, and it should remain until all but the highest lights of the picture has become brown; this may take from fifteen to thirty minutes. The film is then taken from the printing frame and immersed in alum 96 gr., glacial acetic acid 96 gr., water 10 oz., and left in this for several hours, or until sufficient relief is obtained. It is now surface-dried, and a wooden rim formed round it. The plaster of Paris cream is finally poured in and allowed to set, when the gelatine can be stripped off, and the plaster mould can be immersed, face up, in a little melted paraffin wax which it will absorb. As soon as the face of the mould is seen to darken it should be removed, as an excess of wax is not required. The mould can now be used to secure any number of plaster reliefs; or if, instead of waxing, it is well brushed with powdered bronze, an electrotype in metal could be obtained from it. Electro work from plaster is deeply interesting, because it will enable the electrotypist to produce minutely correct copies of carvings or casts, in fact, by employing his scientific resources he can form a valuable collection of works of art, duplicating from the perishable plaster to the durable copper, with all their beauty and all their classic perfection.

RADIOTHERAPY.

A case of leprosy diagnosed by X rays.—Major A. Neve, F.R.C.S.E., Kitchener Indian

Hospital, Brighton. *British Medical Journal*, December 4th, 1915.—The patient complained of headache, and pains in the back and feet. The points that raised a suggestion of leprosy were (*a*) a little clubbing of the fingers, of which the terminal joints were not quite straight and symmetrical; (*b*) the toes appeared slightly shortened, and one of them was crooked.

He was carefully examined for other signs of leprosy, but they were all absent. A radiogram was taken by Captain Gale; it showed entire disappearance of the terminal phalanges of most of the toes. The proximal phalanges had also become greatly decalcified; in the right foot the second phalange only was intact and in the left foot the third, while the big toe of the left foot was only represented by a triangular piece of bone three-quarters of an inch long, and the fifth phalange had quite disappeared.

The distal portions of all the metatarsal bones were extraordinarily thinned.

In the fingers slight changes were perceptible in all the terminal phalanges on both sides. Those of the thumbs were peculiarly eroded and shaped like pollarded willow trunks, and the terminal phalange of the index finger was a mere stump.

It is seldom that a case with slight and doubtful general symptoms shows such extensive osseous changes as to make them the decisive diagnostic factor. Hence the value of the Roentgen rays in this case was peculiar.

RADIUM-THERAPY.

The Action of Radium on Vicious Cicatrices resulting from Wounds.—*Comptes rendus hebdomadaires des Séances de l'Académie des Sciences*, No. 6, 1915, page 146.—Mme. Laborde has studied the action of radium on cicatricial tissue in cases where such tissue appears to be the sole cause of functional impotence, as in the case of fibrous bands causing a limitation of movement, or adhesions in connection with tendons or nerves, in the latter case bringing about more or less severe neuritis. She has carefully avoided destructive doses, employing only rays which have traversed ½ mm. of platinum, according to Dominici's method. The weight of radium salt used has been equivalent to 75 mgm. Ra. Br., contained in two tubes of platinum of the thickness just mentioned, sheathed in 1.5 mm. of caoutchouc and covered by two sheets of gauze. About five or six applications of 1½ hours each, separated by intervals of from five to eight days, were given. No inflammatory reaction was manifested. The first observation had to do with a case in which there was a fibrous band following the direction of the humeral artery up to the fold of the neck. It was the result of a shell wound. The extension of the forearm was limited to an angle of 110 deg. at the maximum. A painful neuritis of the median nerve indicated the compression or irritation of the nerve by the fibrous tissue developed at the level of the cicatrice. There was hypoexcitability to faradic current, and a slow response to galvanic. The author made five applications of radium, of 1½ hours each. In one month almost complete extension of the forearm was obtained. The zone of fibrous tissue totally disappeared, and the neuritis was ameliorated; the acute painful crises disappearing. The movements of flexion of the thumb and index finger were only slightly hampered, and the electrical reactions returned sensibly to normal. There was now very slight hypoexcitability to faradic current, and a greater response to galvanic.

Another case was that of a man who had had a fracture of the neck of the humerus by a shell, and was immobilized for forty days. Mechanotherapy brought about amelioration of the ankylosis of the shoulder. There was a complete paralysis of the biceps; no voluntary contraction was possible. The electrical examination showed faradic inexcitability, and very slow reactions to galvanic current. It appeared logical to think that the musculo-cutaneous nerve was compressed at the level of a cicatrice, forming a linear furrow, very adherent to the bone, situated at the antero-internal region of the arm, immediately under the projection of the grand pectoral. Six radium applications of 1½ hours each were given, and six days after the second sitting the voluntary contractility reappeared in the biceps, at the same time as the faradic excitability. The augmentation of force in the biceps increased rapidly, and all the voluntary movements returned. The reaction of degeneration still persisted, but it was partial, and the normal condition was evolving. To the faradic current there was slight hypoexcitability, and to the galvanic a less tardy reaction. The author concludes that radium irradiation appears to exercise an elective influence of regression on certain cicatricial tissues, and that it is a method which merits trial in order to liberate nerves or tendons included in such tissues, without fear of the formation of new adhesions.

X-RAY TECHNIQUE.

Selenium as a means of Measuring X-ray Energy.—*Phys. Zeitschrift*, 1915, page 209.—Woltz, as a result of some experiments, concludes that the selenium method is practically without value as a means of measuring the energy of the Roentgen rays. Many photometers rest on the principle of the variation of the resistance of selenium when it absorbs luminous energy, but he is entirely against the extension of this principle to the measurement of the intensity of X-ray radiation. It is not possible to utilise selenium for exact measurements of this kind. The value of the measures based upon the variation of the resistance of the selenium are strongly affected by various factors, such as time and frequency, so much so, indeed, that the averages deduced from a great number of observations of measurements of quantity of energy with the selenium cell have not been recognised as having any concordance with those obtained by the ionisation method.

CORRESPONDENCE.

To the Editors of ARCHIVES OF RADIOLOGY AND ELECTROTHERAPY.

DEAR SIRS,—There are two lines of misprints in Dr. Salomonson's article in the February number of the ARCHIVES, on "How to measure the thickness of the wall of an X-ray tube," which will be somewhat confusing to anyone who attempts to follow the mathematical proof on p. 314. The lines which follow equation (3) should read:

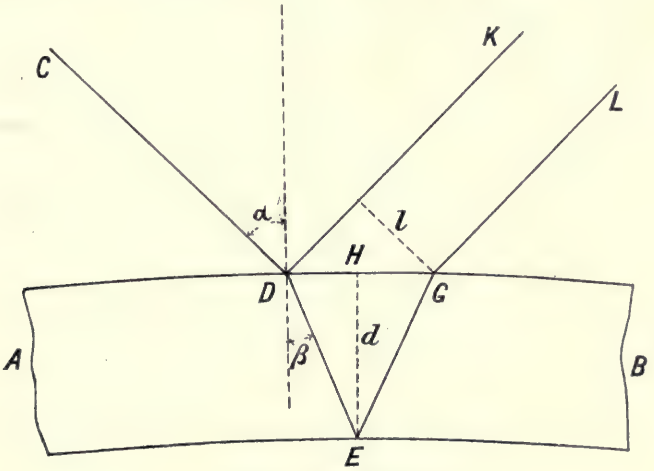


FIG. 1 (reproduced).

As $\sin\beta = \frac{1}{n} \sin\alpha$ and $\alpha = 45°$ we find:—

$$\sin\beta = \frac{1}{\sqrt{2}} \cdot \frac{1}{n} \text{ and from this } \cot\beta = \sqrt{2n^2 - 1}.$$

The final formula given is correct for the case for which it is worked out.

But the assumption that we can consider the wall of the tube as being perfectly plane is obviously an exceedingly treacherous one, and further examination is necessary to see whether in any case it is justifiable. This further examination requires rather more complicated mathematics than we need to reproduce here. But the following points may be mentioned. The virtual images of the distant source of light are *in no case* coincident with the wall of the vessel. In the case of a plane surface they are the same distance behind that the source is in front (viz. 4 or 5 metres). This is not important when the wall is plane, because their distance apart (L) is then equal to h on Dr. Salomonson's diagram (Fig. 1, p. 314). When the wall is curved the images lie at nearly equal distances, whose value is less than the radius of curvature (which is probably less than 20 cms.). Besides this change, the two rays, DK and GL, are inclined to one another at an angle depending upon the curvature of the wall. The result is that the images are less than the distance l apart. As to how much less depends upon the relative values of the data of the problem. If p is the distance of the object from the wall, R the radius of curvature of the outer surface, d the thickness, L the distance between the images, then the following equation is nearly exact for $a = 45°$ and $n = 1.53$.

$$d \left\{ \cdot 7375 \left(\frac{\sqrt{2}\, p + R}{2\sqrt{2}\, p + R} \right) + \frac{L}{R} \right\} = L.$$

In special cases this takes simpler forms. When R is infinite (*i.e.*, the surfaces plane)—

$$d = \frac{L}{\cdot 7375} = 1 \cdot 355\, L.$$

This is Dr. Salomonson's formula.

When p is much greater than R, and R is much greater than L, a state of things which would hold good in actual practice,

$$d = \frac{2\, L}{\cdot 7375} = 2 \cdot 710\, L \text{ nearly};$$

that is, it is twice the value given by the previous formula.

Yours faithfully,

ALFRED W. PORTER.

NOTICES.

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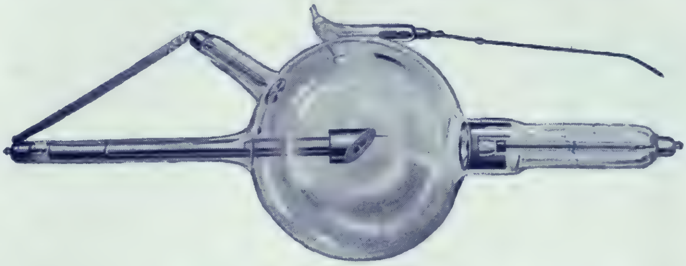

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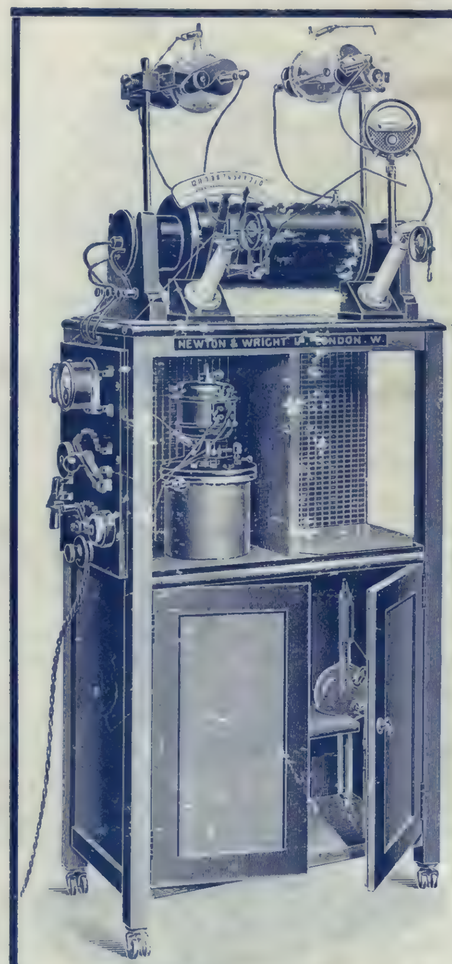

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